Examining Impacts of Marine Foraging Strategies in Prehistoric Hawai‘i

Honors Research Thesis

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ABSTRACT

Prehistoric Hawaiian populations utilized many resources to satisfy daily nutritional demands. Fish were one of the most important sources of food for prehistoric populations throughout Hawai‘i. This project focuses on an archaeological collection of fish remains recovered from the Kohala coast, located on the northern portion of the island of Hawai‘i. The goal of this research project is to better understand prehistoric foraging strategies and to determine if resource depression (i.e., declines in harvested fish) occurred in the study period, AD 1400-1800. This was done using data obtained from the analysis and quantification of fish remains. Testable models of resource depression based on predictions of foraging theory were used in statistical analysis. The results show significant change through time in use of marine resources, but do not indicate the occurrence of resource depression in Kohala. These results have provided into the dynamics of prehistoric foraging in Kohala, and allow for further assessment of settlement patterns and population growth over time.

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CONTENTS

FRONT MATTER

List of Figures…………………………………………………………………………vi

List of Tables…………………………………………………………………………..ix

CHAPTER 1: INTRODUCTION……………………………………………………………1

Part 1: Resource Depression in Prehistory………………………………………………1

Part 2: Harvesters of the Sea………………………………………………………...4

Part 3: Hawaiian Socio-Political Organization at Contact………………………………5

CHAPTER 2: PROJECT BACKGROUND……………………………………………………8

Part 1: A Brief Introduction to Hawaiian Prehistory……………………………………..8

Part 2: The Leeward Kohala Field System………………………………………………13

Part 3: Resource Depression in Kohala? ……………………………………………….18

CHAPTER 3: MATERIALS AND METHODS……………………………………………...20

Part 1: Foraging Theory Models in Archaeological Studies……………………………20

Part 2: Quantitative Analysis Using Foraging Theory Models………………………….23

Part 3: Laboratory Analysis of Ichthyofaunal Remains…………………………………25

CHAPTER 4: RESULTS……………………………………………………………………31

Part 1: Results of the Analysis of the Ichthyofaunal Assemblage………………………..32

Part 2: Taxonomic Ranking……………………………………………………………...54

Part 3: Analyses of Faunal Assemblage for Evidence of Resource Depression…………62

Part 4: A Brief Statistical Analysis of the General Faunal Assemblage………………...91

CHAPTER 5: DISCUSSION………………………………………………………………104

Part 1: Marine Resource Use Through Time in Kohala………………………………104

Part 2: Limitations of This Analysis……………………………………………………108

CHAPTER 6: CONCLUSION……………………………………………………………….112

REFERENCES CITED…………………………………………………………………….113

APPENDICES………………………………………………………………………………119

Appendix 1: Example of recording spreadsheet………………………………………..119

Appendix 2: Diagrams of how each type of element was measured…………………...120

Appendix 3: List of excavation units with faunal material……………………………..123

Appendix 4: Table of identified ichthyofaunal material………………………………..125

Appendix 5: Table of evenness, NTAXA, and densities for each excavation unit…….183

LIST OF FIGURES

Figure 1.1: The Hawaiian Islands. Source: Google Earth……………………………………...3

Figure 1.2: Kohala, Hawai‘i, showing *ahupua‘a* divisions. Inset source: Google Earth………....3

Figure 1.3: The hierarchy of Hawaiian socio-political organization at contact (Kirch 1985: pg. 6)……………………………………………………………………………………………..6

Figure 2.1: Pacific Islands map, showing the Hawaiian Islands and their two proposed homelands: Tahiti and the Marquesas (from http://www.geographicguide.com/oceania-map.htm)..9

Figure 2.2: The revised culture sequence for the Hawaiian Islands (Kirch 2010: pg. 128)……..10

Figure 2.3: Estimated population curve for the Hawaiian Islands (Kirch 2010: pg. 134)……….12

Figure 2.4: The Leeward Kohala Field System, showing *ahupua‘a* under study in this project (Field et al. 2011: pg. 7328)………………………………………………………………...14

Figure 2.5: LiDAR image of a portion of the LKFS, showing field alignments and boundaries (Field et al. 2011: pg. 7329)………………………………………………………………...15

Figure 2.6: The number of dated residential features analyzed by Field et al. 2008, 2009, 2010a (Field et al. 2011: pg. 7329)………………………………………………………………...17

Figure 3.1: The general skeletal anatomy of bony fish (Wheeler and Jones 1989: pg. 88)……...27

Figure 3.2: Examples of “special bones” of fish (Photos by J. Lipphardt unless otherwise indicated)……………………………………………………………………………………28

Figure 4.1: The *ahupua‘a* under study in this project, showing excavation units that contained faunal material……………………………………………………………………………...34

Figure 4.2: The identified fish remains from Kohala…………………………………………35

Figure 4.3: NISP and MNI of identified fish from Kaiholena, period 2…………………………37

Figure 4.4: NISP and MNI of identified fish from Kaiholena, period 3…………………………38

Figure 4.5: NISP and MNI of identified fish from Kālala, period 2……………………………..40

Figure 4.6a: NISP of identified fish from Kālala, period 3……………………………………...41

Figure 4.6b: MNI of identified fish from Kālala, period 3………………………………………41

Figure 4.7a: NISP of identified fish from Kālala, period 4……………………………………...42

Figure 4.7b: MNI of identified fish from Kālala, period 4……………………………………42

Figure 4.8: NISP and MNI of identified fish from Makeanehu, period 1………………………44

Figure 4.9a: NISP of identified fish from Makeanehu, period 2………………………………...45

Figure 4.9b: MNI of identified fish from Makeanehu, period 2…………………………………45

Figure 4.10a: NISP of identified fish from Makeanehu, period 3………………………………46

Figure 4.10b: MNI of identified fish from Makeanehu, period 3………………………………..46

Figure 4.11: NISP and MNI of identified fish from Makiloa, period 1…………………………49

Figure 4.12a: NISP of identified fish from Makiloa, period 2…………………………………...50

Figure 4.12b: MNI of identified fish from Makiloa, period 2…………………………………...50

Figure 4.13a: NISP of identified fish from Makiloa, period 3…………………………………..51

Figure 4.13b: MNI of identified fish from Makiloa, period 3…………………………………...51

Figure 4.14a: NISP of identified fish from Pahinahina, period 1………………………………..53

Figure 4.14b: MNI of identified fish from Pahinahina, period 1………………………………...53

Figure 4.15: Prey index values of *Scaridae* spp. vs. *Labridae* spp………………………………64

Figure 4.16: Evenness and NTAXA of the Kaiholena ichthyofaunal assemblage………………66

Figure 4.17: Evenness and NTAXA of the Kālala ichthyofaunal assemblage…………………..68

Figure 4.18: Evenness and NTAXA of the Makeanehu ichthyofaunal assemblage……………..70

Figure 4.19: Evenness and NTAXA of the Makiloa ichthyofaunal assemblage………………...72

Figure 4.20: Evenness and NTAXA of the Pahinahina ichthyofaunal assemblage……………...74

Figure 4.21: NTAXA of the combined Kohalan ichthyofaunal assemblage……………………76

Figure 4.22: Average NTAXA of each *ahupuaʻa*……………………………………………….77

Figure 4.23: Evenness of the combined Kohalan ichthyofaunal assemblage……………………78

Figure 4.24: Average evenness of each *ahupuaʻa*………………………………………………79

Figure 4.25: NISP of identified fish from different ocean biotic zones…………………………81

Figure 4.26: Size of *Balistidae* spp. first dorsal spines through time……………………………84

Figure 4.27: Size of *Monacanthidae* spp. first dorsal spines through time……………………...85

Figure 4.28: Size of *Labridae* spp. lower pharyngeal plates through time………………………86

Figure 4:29: Size of *Scarus/Chlorurus* sp. lower pharyngeal plates through time………………87

Figure 4.30: Size of *Calotomus* sp. lower pharyngeal plates through time……………………...88

Figure 4.31: Size of *Scarus/Chlorurus* sp. upper pharyngeal plates through time………………89

Figure 4.32: Size of *Calotomus* sp. upper pharyngeal plates through time……………………...90

Figure 4.33: A comparison of NISP and MNI of fish in the Kohalan assemblage………………93

Figure 4.34a: The NISP of the entire Kohalan faunal assemblage………………………………94

Figure 4.34b: The weights of the entire Kohalan faunal assemblage……………………………94

Figure 4.35: The faunal densities for Kohala……………………………………………………95

Figure 4.36: The NISP and weight evenness values for the Kohalan faunal assemblage……….97

Figure 4.37: The average evenness values for Kohala, using NISP and weight………………...97

Figure 4.38: NISP of identified fish in coastal and upland sites…………………………………99

Figure 4.39: NTAXA and evenness of the identified ichthyofaunal assemblage for coastal and upland sites……………………………………………………………………………………99

Figure 4.40a: Fish NISP for coastal and upland sites…………………………………………..100

Figure 4.40b: Fish weight for coastal and upland sites…………………………………………100

Figure 4.41: Proportions of fish, by NISP and weight, within the total faunal assemblage for coastal and upland sites………………………………………………………………………101

LIST OF TABLES

Table 4.1: Period 1 rankings…………………………………………………………………..55

Table 4.2: Period 2 rankings…………………………………………………………………..57

Table 4.3: Period 3 rankings…………………………………………………………………..59

Table 4.4: Period 4 rankings…………………………………………………………………..61

Table 4.5: Identified taxa in coastal and upland sites……………………………………………..102

Chapter 1: Introduction

Part 1: Resource Depression in Prehistory

Hawai‘i is a fisherman’s paradise. The fish are large and plentiful, and live in the waters surrounding the archipelago year-round. Over 650 kinds of fish are present in the waters surrounding Hawai‘i, along with many other species of marine life (MacKellar 1968). Ancient Hawaiians made a living off fishing these bountiful waters, and that tradition has been present throughout the entirety of Hawaiian prehistory. However, modern biological studies suggest that a heavy reliance on marine resources could have had a negative impact on the resource base of the archipelago. Harvesting pressures placed on exploited populations of fish can cause a decline in their population numbers, known as resource depression (Butler and Campbell 2004).

The Hawaiian ecosystem is not static; since people first settled in the archipelago, approximately AD 1000-1200 (Wilmshurst et al. 2011; Rieth et al. 2011) natural and human forces have been shaping the local environment. Hawaiians acquired their food from the land and the ocean, and their survival relied on the resources of the islands. The occurrence of resource depression shows the negative impact that peoples’ actions can have on their local environment. The occurrence of resource depression also provides insight into the management (or mismanagement) of resources by the local chiefs. This type of research can be applied to studies of modern conservation biology, since it provides researchers with a long-term picture of human resource management in an area. Through studying the use of and management of animal populations in the past, we can better understand how modern harvesting and management strategies affect these populations (Lyman and Cannon 2004).

To study resource depression in the archaeological record, zooarchaeological analysis and quantitative models are used (Morrison and Hunt 2007, Nagaoka 2002, Butler 2000). In light of declines seen among modern fish as a result of overharvesting (Conover et al. 2009), there is a very real possibility of the occurrence of resource depression in prehistoric times. The study area included a large portion of agricultural land, the Leeward Kohala Field System (LKFS), which was an area of intensive food production in prehistory (Field et al. 2010b, 2011, Ladefoged et al. 2003). The production of these fields sustained the Kohalan population and provided surplus for chiefly demands. This project examines the possibility that resource depression stemming from overfishing that may have occurred in prehistoric Hawai‘i, using fish remains recovered during archaeological excavations in Leeward Kohala, Hawai‘i (Figures 1.1 and 1.2). This project also examines changes in fishing through the last 400 years of Hawaiian prehistory.

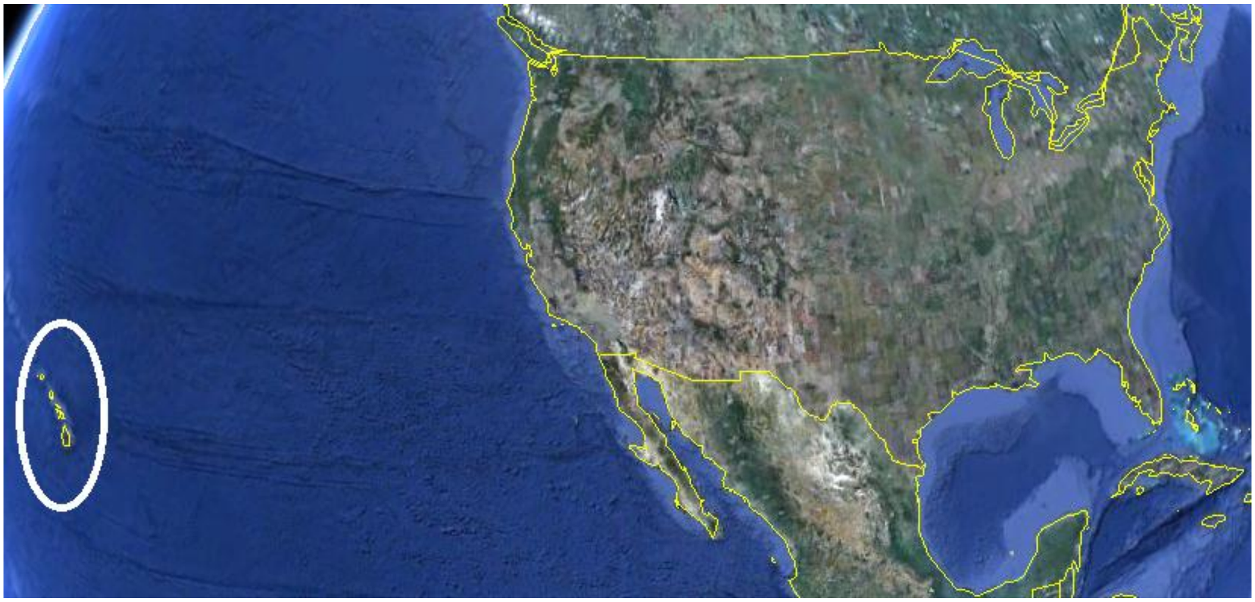


Figure 1.1. The Hawaiian Islands. Source: Google Earth.

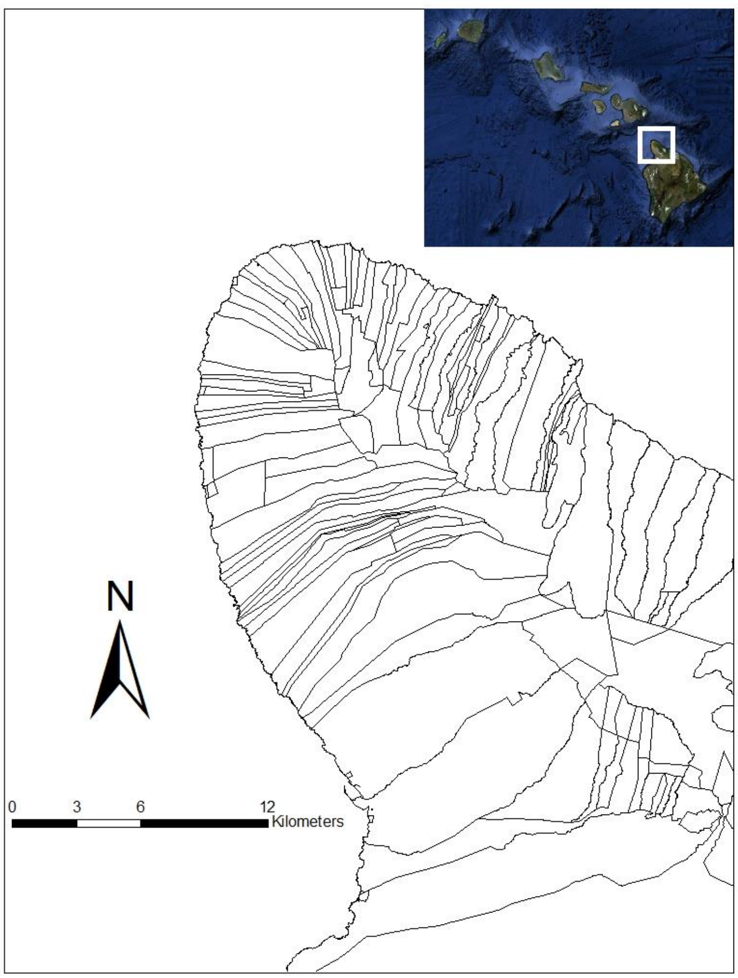


Figure 1.2. Kohala, Hawai‘i, showing *ahupua‘a* divisions
Inset source: Google Earth.

Part 2: Harvesters of the Sea

The fisherman (*po'o lawai'a*) in prehistoric Hawai'i was a knowledgeable and important person (Titcomb 1972). Fishermen knew their grounds and quarry intimately. They knew the spawning histories and habitats of many different kinds of fish. Fishermen had detailed knowledge of the local reefs, ocean topography and weather conditions affecting the local marine life (MacKellar 1968). Fishermen used a plethora of fishing strategies, suited to different areas of the ocean, weather conditions, and which prey the fisherman was seeking. These strategies include spearing, netting, trapping, noosing, poisoning, angling, deep-sea trolling, fishpond cultivation, and hand-fishing (Mackellar 1968; Kamakau 1976; Buck 2003; Kirch 1982). The Hawaiian fishing toolkit was broad and diverse, encompassing different kinds of canoes, nets, fishing line, bait, and fishhooks (Kamakau 1976; Emory et al. 1968).

Fishing was an important practice throughout Hawaiian prehistory, for fish and other marine animals "were designed to go with *poi*" (MacKellar 1968). Mashed sweet potato and other starchy agricultural products (e.g., taro, yam) are called *poi* in Hawai'i. Ethnohistory informs us that Hawaiian food had two primary components: *'ai* (a starch staple such as taro, sweet potato, breadfruit or yams) and *i'a*, (fish, or some other "flesh food") (Kirch and O'Day 2003). These foods composed the everyday diets of commoner (*maka'āinana*) and elite *(ali'i)* meals (Kirch 1985). Since fish and fishing were an integral part of Hawaiian everyday life, and the demand for fish was high, it is important to understand the role they have played in subsistence throughout prehistory. Zooarchaeological investigation can reveal more information about the importance of marine resources in Kohala.

Archaeology has revealed that fishing has a long cultural history in Hawai'i. Remains of fish which are favorite foods in modern Hawai'i have been found in archaeological excavations

(Kirch 1979). However, most of the tools associated with fishing are not recovered, with the exception of bone and shell fishhooks and sea urchin spine files used to shape fishhooks (Emory et al. 1968; Kirch 1979). Other artifacts, such as stone sinkers similar to those used in cowrie-shell lures, are nearly identical to tools used by modern fishermen. Finds such as these allow for an understanding of the historical depth of certain fishing strategies.

Part 3: Hawaiian Socio-Political Organization at Contact

The Hawaiian archipelago is the setting for the most stratified society recorded in Polynesian history. The degree of hierarchy and social stratification of the islands' population have led researchers to label Hawai'i as an 'archaic state' (Kirch 2000, 2010; Kirch and O'Day 2003). The Hawaiian Islands were thought to have been settled around AD 1000-1200 (Wilmshurst et al. 2011; Rieth et al. 2011; cf. Kirch and McCoy 2007). By AD 1400-1500, the population was large, permanent settlements were present on the islands, territories were beginning to form, and the first agriculture on the islands was seen (Kirch 1984, 1985). At the time of European contact in 1779, Hawaiian subsistence was based on intensive agriculture, cultivation, and marine foraging, and systems of land division were in place. *Moku* were larger divisions that cross-cut each island, and *ahupua'a* were smaller territories, each controlled by a local chief, or *ali'i 'ai ahupua'a,* and managed by an *ahupua'a* administrator, or *konohiki* (Kirch 1985). Each *ahupua'a* also had an administrative hierarchy which was responsible for overseeing and managing land production (Figure 1.3). *Ahupua'a* had household communities associated with them, and these households worked the land to produce food and a surplus tribute for their chiefs (Kirch 1985).

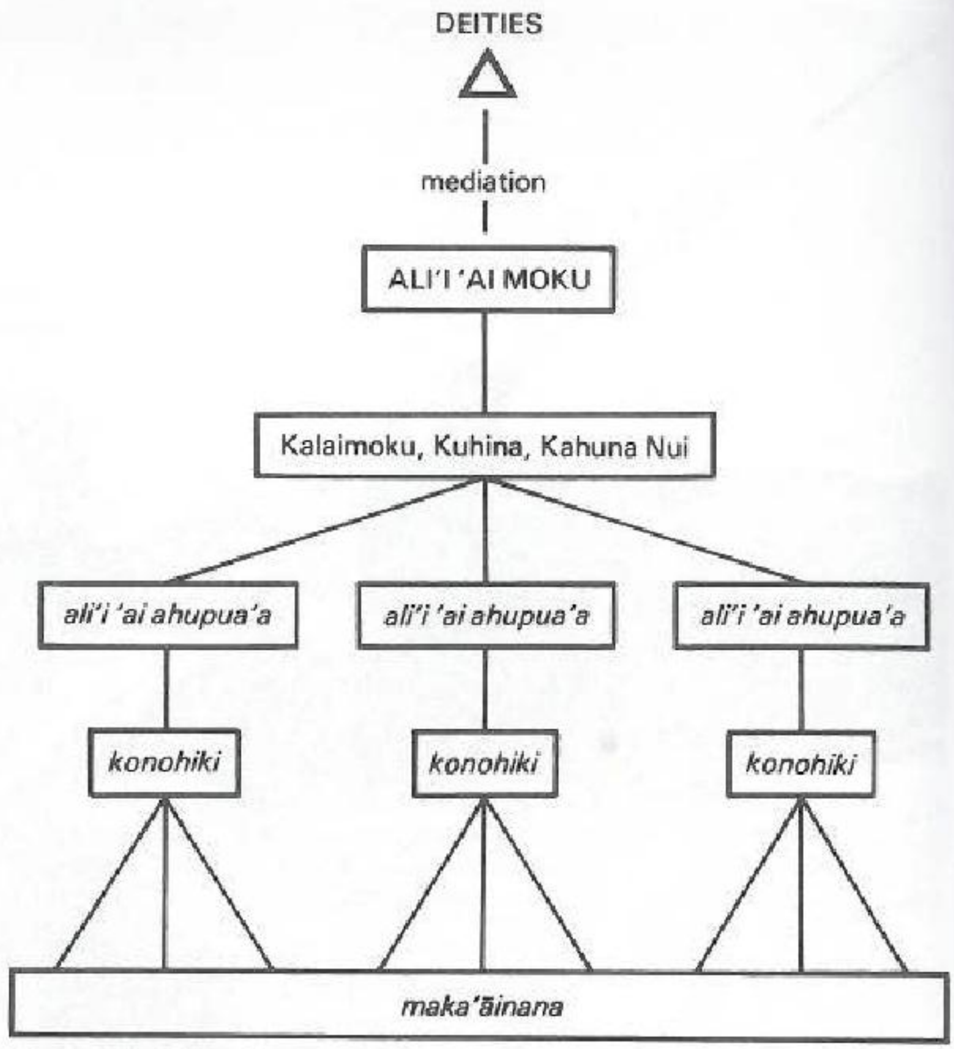


Figure 4. Hawaiian society at European contact was hierarchically organized, with several grades of chiefs *(ali'i)* and land managers *(konohiki)* over the large class of commoners *(maka'āinana)*. *(Kirch 1984)*

Figure 3. The hierarchy of Hawaiian socio-political organization at contact (Kirch 1985: pg. 6).

The Hawaiian chiefs were important, multi-purpose figures in prehistory, serving as administrators and spiritual leaders (Kirch 2010). The chief was infused with *mana*, or sacred power. *Mana*, along with *tapu* and *noa*, was central to Hawaiian religious beliefs (Kirch 2000), bolstering the power of the chiefs in prehistory. *Tapu,* or *kapu,* means restricted or forbidden, and involved strict social rules and behaviors in prehistoric Hawai‘i (Kirch 1985). *Noa* means “a lifting of restriction”, the opposite of *kapu* (Connors 2009: pg. 21). Hawaiian chiefs demanded surplus production of foods by commoner households to be used in feasting and other ritual activities. Household groups, or *kauhale,* were the “primary economic units” within this production system (Field et al. 2010a).

Significant subsistence changes seen in the Hawaiian archaeological record can be correlated with changing social structure and the “rise of differential status and hierarchy’’ (Kirch and O’Day 2003). The production of the agricultural surplus needed to fulfill chiefly demands and feed the growing population fueled the intensification of field systems in Hawai‘i (Ladefoged et al. 2003). This development is also reflected in the demand for fish, which produced the rich zooarchaeological record of the Hawaiian Islands.

Chapter 2: Project Background

Part 1: A Brief Introduction to Hawaiian Prehistory

Kirch (1984, 1985, 1990, 2000, 2007, 2010) has described the complex socio-political system seen in contact-era Hawai‘i as an ‘archaic state’. This system emphasized surplus production in order to support an elite caste of society, creating the potential for resource mismanagement and resource depression in prehistory. But what historic events lay behind the formation of the ‘Hawaiian state’?

The first two questions to ask are “from where?” and “when?” The homeland of the Hawaiians is generally agreed to be the Marquesas or Tahiti (Figure 2.1), but a diverse ancestral population and the potential for multiple contacts is also probable (Kirch 2000). However, the settlement date for the Hawaiian Islands is hotly debated. Early archaeological work placed the colonization date at approximately AD 300 (Kirch 1985), but recent re-dating has yielded much younger dates: between AD 800-1000 from Bellows Beach on Oahu (Kirch and McCoy 2007) and AD 1300 and from the Pololu Valley on Hawai‘i Island (Field and Graves 2008). Based on these dates, Kirch (2010) has proposed a revised cultural sequence for the Hawaiian Islands (see Figure 2.2).

Figure 2.1. Pacific Islands map, showing the Hawaiian Islands and their two proposed homelands: Tahiti and the Marquesas (from http://www.geographicguide.com/oceania-map.htm).

TABLE 4.1. A REVISED HAWAIIAN CULTURAL SEQUENCE

Time Span (AD)	Period	Salient Characteristics
(800?) 1000–1200	Foundation	Initial discovery and settlement by Polynesian colonists from central Eastern Polynesia. Small founding population; settlements in a few ecologically favorable locations, primarily on O'ahu and Kaua'i Islands.
1200–1400	Early Expansion	The last period with long-distance voyaging contacts with central East Polynesia. Beginning of major phase of exponential increase in population. Adaptation of technology and subsistence economy to local conditions. Development of significant taro irrigation systems on O'ahu, Kaua'i, and Moloka'i islands.
1400–1650	Late Expansion	Population growth peaks and begins to stabilize. Expansion of settlements into leeward and marginal zones, and initial formation of large-scale dryland field systems on Maui and Hawai'i islands. Considerable investment in monumental architecture. Archaic states emerge at the end of this period.
1650–1778	Protohistoric	High-density but stable (not expanding) population. Settlements across all ecological zones. Secondary intensification of dryland field systems. Conquest warfare endemic.

Figure 2.2. The revised culture sequence for the Hawaiian Islands (Kirch 2010: pg. 128).

Based upon archaeological investigations, early Hawaiian settlements were few in number, and located on the windward coasts of the islands, where irrigated agriculture could be most easily established (Kirch 1985). Based upon the remains of shell, bone, and household tools, the people subsisted on marine resources (such as fish, mollusk, octopus, and squid), taro cultivation, tree crops, and domestic animals (primarily chicken, but also dog and pig). The material culture was diverse, and included many fishing implements that are common throughout East Polynesia (hooks, nets, and sinkers), basalt adzes, and shell and bone tools and ornaments (Buck 2003).

The first Hawaiians brought plants and animals from their homeland, and systems of cultivation, irrigated agriculture, and extensive aquaculture quickly expanded throughout the islands. Once the sweet potato (*Ipomoea batatas*), was introduced after the 14th century (Ladefoged et al. 2005), food production expanded to the dry, leeward sides of Maui and Hawai‘i (Kirch 1985). With the expansion of food production and procurement, Hawaiian population also grew (Figure 2.3). This development was driven by the island chiefs (Kirch 1985). Production of surplus foodstuffs drove the growth and intensification of ritual activity, which in turn drove an increase in the intensification of food production and population, and the system continued to quickly build, until the arrival of Captain James Cook in 1779.

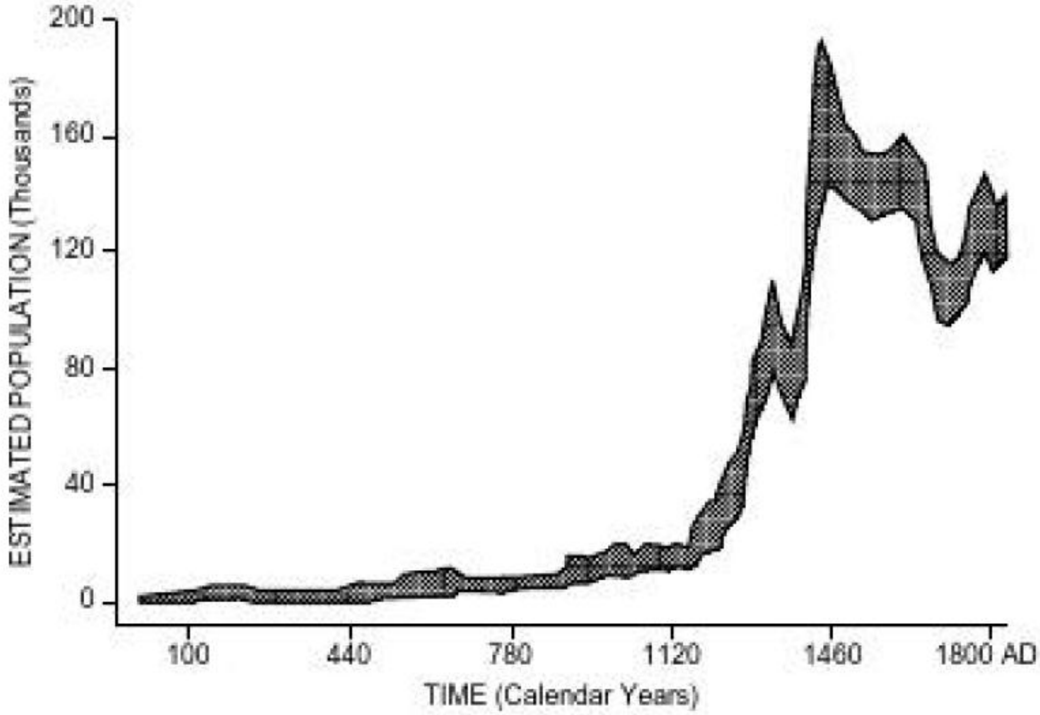


Figure 4.2. The Dye-Komori population curve, based on the cumulative probability distributions of 598 radiocarbon dates from the Hawaiian Islands. (*Source:* Redrawn after Dye and Komori 1992.)

Figure 2.3. Estimated population curve for the Hawaiian Islands (Kirch 2010: pg. 134).

Part 2: The Leeward Kohala Field System

The archaeological remains of an extensive agricultural system on the northernmost tip of Hawai‘i Island have been designated as the Leeward Kohala Field System (LKFS) (Figure 2.4). The landscape is marked by earthen berms, trails, residential and ritual structures (Figure 2.5). The LKFS was contained within many *ahupua‘a* reaching from the mountains to the coast. Recent research suggests that households living near the coast fished intensively and households in the field system farmed intensively (Field et al. 2011). The sweet potato was the main crop of the Kohala field system, but other plants such as sugar cane, gourd, and dryland taro were also grown (Ladefoged et al. 1996). It has been hypothesized that sweet potato grown in the uplands was transported to the coast, and marine foods from the coast were transported to the uplands. Through time, agricultural production within the LKFS intensified, and the field system grew in area (Ladefoged et al. 2003; Field et al. 2011).

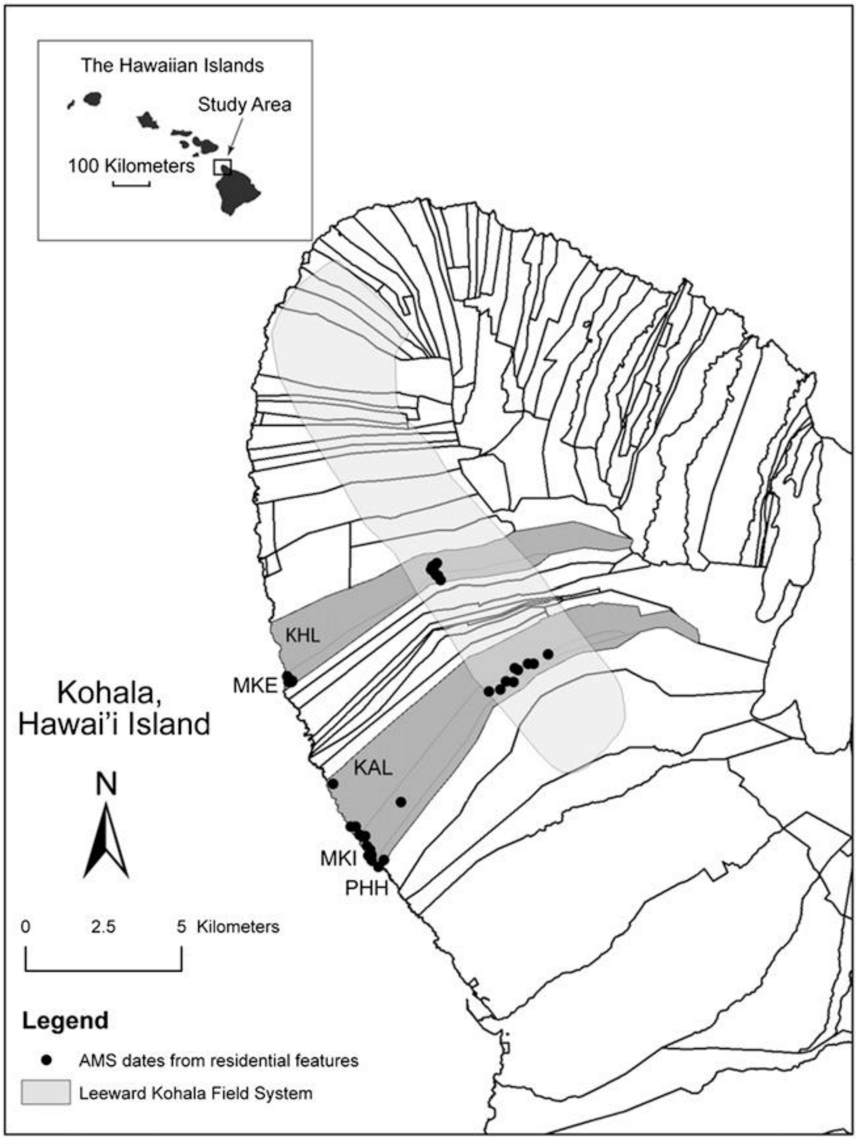


Figure 2.4. The Leeward Kohala Field System, showing *ahupuaʻa* under study in this project (Field et al. 2011: pg. 7328).

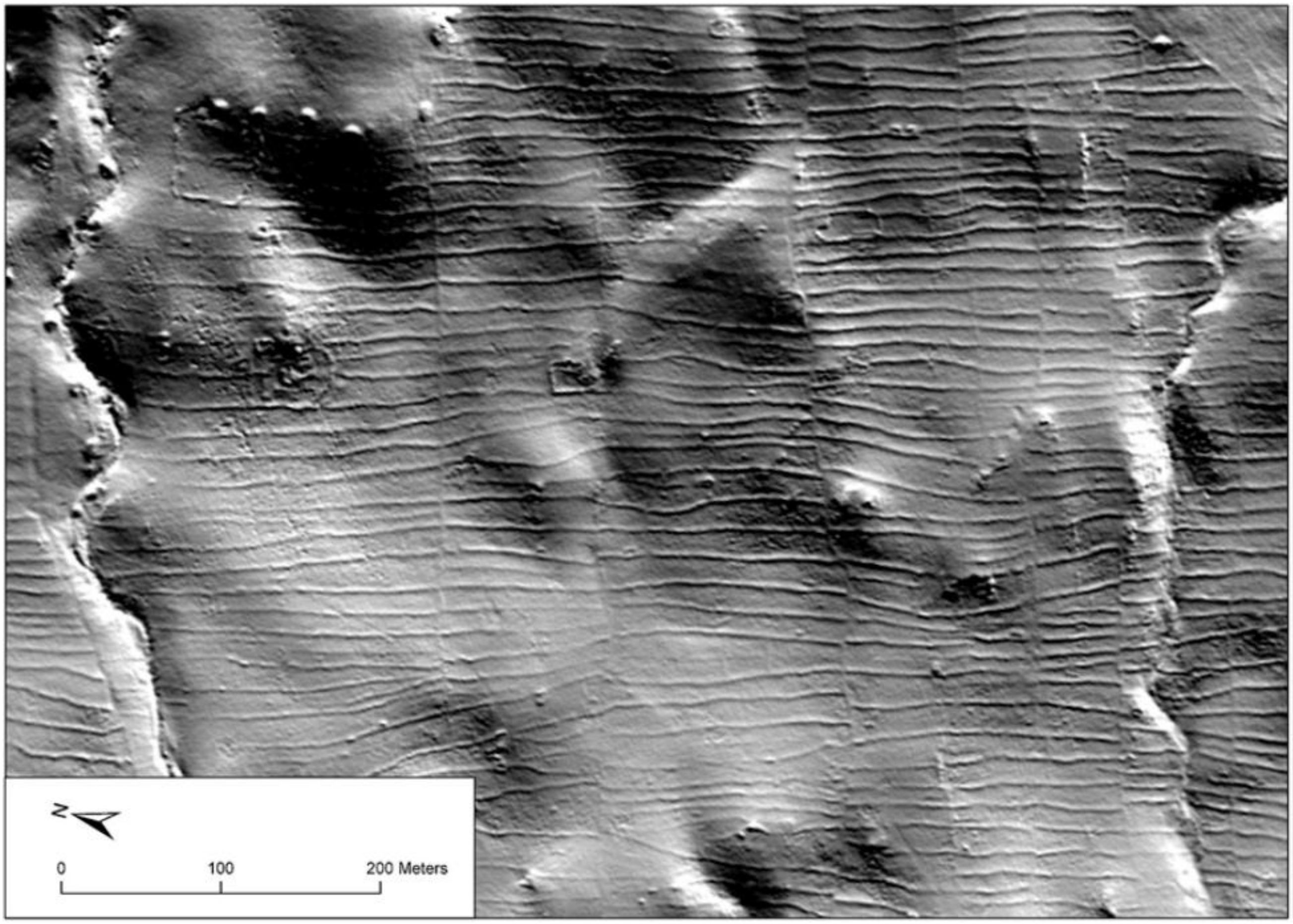


Figure 2.5. LiDAR image of a portion of the LKFS, showing field alignments and boundaries (Field et al. 2011: pg. 7329).

Recent research indicates that the households that were distributed across the landscape were responsible for the production of the agricultural goods and surplus that maintained the complex socio-political environment of the Hawaiian Islands. The household was, for a large part of Hawaiian prehistory, self-sufficient. In later prehistory in the Kohala area, as the number and size of households in the *ahupuaʻa* grew, the household dynamic shifted in accordance with changing social contexts to one geared to surplus production (Field et al. 2010b, 2011).

The growth of the field system has been examined by Ladefoged et al. (2003) through the examination of the building sequences of trails and field boundaries. These studies indicate that land within the LKFS was subdivided further and further with increasing agricultural production later in prehistory. However, the potential for agricultural production differed throughout the field system. Some *ahupuaʻa* may have been able to produce more food and surplus than others (Ladefoged et al. 2009). In addition, the role of ritual activities in Hawaiian society, which required surplus agricultural product, was a large driving force in the expansion of agriculture in Kohala and throughout the Islands (McCoy and Graves 2010). Hawaiian commoners had to increase production later in prehistory to match the demands for surplus from Hawaiian chiefs.

Research conducted by Field et al. (2011) showed an increase in the number of households in Kohala from AD 1400-1800 (Figure 2.6). The period from AD 1650-1800 shows a marked increase in residential features on the landscape, in both coastal and inland areas. This demographic change coincides with the intensification of agricultural production in Kohala. With the increase in population later in prehistory, it is proposed that fishing and collection of other marine resources in Kohala intensified. This observation prompts archaeologists to ask "Was there resource depression in Kohala? If there was, can we measure it?"

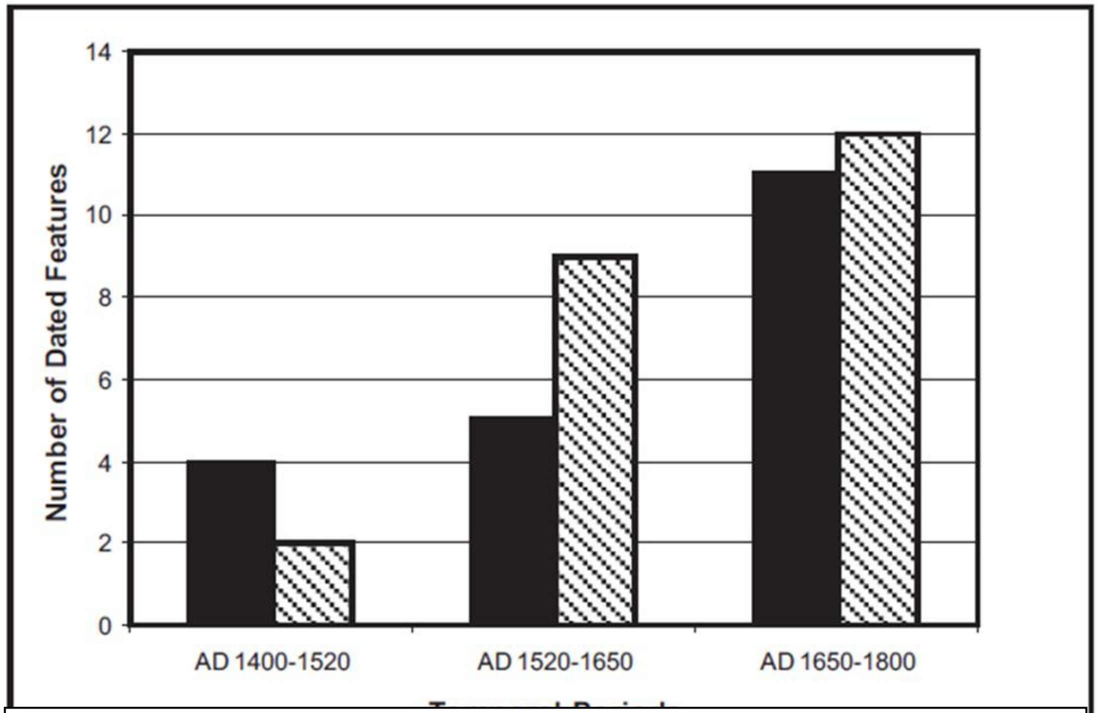


Figure 2.6. The number of dated residential features analyzed by Field et al. 2008, 2009, 2010a (Field et al. 2011:pg. 7329).

Part 3: Resource Depression in Kohala?

Resource intensification and resource depression has been documented in the global archaeological record (Grayson 2001). Human populations in prehistory impacted mammal and marine populations throughout the United States. In a landmark study, Broughton (1994) studied the impact on prehistoric sturgeon populations in San Francisco, and later identified resource intensification of land animals in the Sacramento Valley (Broughton 1997). Similarly, Butler (2000) provides evidence for depression of marine resources along the Columbia River in northwest Oregon.

Throughout prehistory in the Pacific Islands, human populations had an impact on local animal life. Oceania is well known for its cases of human-induced extinction of native bird populations (Redman 1999; Steadman 2006). Butler (2001) and Nagaoka (2002) demonstrate that depression of fish populations occurred on Mangaia, and *moas* (flightless birds) and seals declined in prehistoric New Zealand. These studies provide researchers with new insight into human use and management of animal populations in prehistory, and can offer information crucial to the study of human impact on animal populations over the long term (Grayson 2001).

In the Hawaiian Islands, studies of prehistoric resource intensification have focused on mollusk gathering. Morrison and Hunt's (2007) analyses indicate that shoreline mollusk populations along the coast of Kaua'i were stable in prehistory, while mollusk species living further from the shore declined through time. This research demonstrates that an intensification of harvesting by human populations does not always culminate in resource depression. McCoy (2008) also provides evidence of lessening of pressures on mollusks in post-contact Moloka'i. After European contact, the population of the Hawaiian Islands decreased, and harvesting pressures on limpet populations were significantly less than in prehistory. Mollusks provided a large amount of food to prehistoric Hawaiians, and since their remains tend to preserve better than smaller and more fragile fish bones, they typically provide a larger data set to analyze (Stahl 2006). However, since fishing was integral to the diet, it is important to analyze ichthyofaunal remains from prehistoric sites whenever possible.

Models of resource depression are based on optimal foraging theory (Stephens and Krebs 1986), which models the maximization of energetic and caloric return for foraging activities. The model proposes that foragers make choices about where and what to gather, hunt, or fish based on the amount of food they can collect while putting in the least amount of energy. Since the productivities of certain areas differ, foragers prefer areas (known as patches) of more efficient exploitation over those which are less efficient (Morrison and Hunt 2007). Using foraging theory to model for optimal foraging strategies by humans, archaeologists can examine changes in faunal exploitation through time and compare the results to theoretical models. These models will be discussed in detail in Chapter 3.

Chapter 3: Materials and Methods

Resource depression in prehistory can be analyzed by using the results of zooarchaeological analysis to test predictions of foraging theory models. This study used ichthyofaunal analysis (the analysis of skeletal fish remains), to test for resource depression in Kohala, Hawai‘i. The results of the quantitative analysis will provide evidence for resource depression only if all predictions proposed by the foraging theory models are met.

Part 1: Foraging Theory Models in Archaeological Studies

Foraging theory models provide a useful scientific tool to study human food gathering strategies in the past and present. Often termed “optimal foraging”, these models are central to studies of modern hunter-gatherers by human behavioral ecologists (HBE), and these mathematical models provide testable, quantitative hypotheses that can be tested using data gathered during research. For archaeological studies, these models serve as a tool for understanding what occurred in the past. Since archaeologists cannot observe foraging behavior or directly interact with prehistoric peoples, these models provide correlates for behavior and foraging activities in the past.

The fundamental concepts of HBE models are marginal valuation, opportunity costs, discounting, and risk-sensitive behavior (Kennett and Winterhalder 2006). Marginal valuation refers to the variable value of food or goods. Most of the food we consume does not consistently hold the same degree of attractiveness, or constant value, to us. Although the fundamental value of a food or object does not change (e.g., the caloric content remains the same), our opinion of its value decreases with time as we are exposed to this food or object, or with the amount we have of this food or object. Over time, the value of foods or objects can become marginalized. Opportunity costs refers to potential losses which occur, when moving from pursuing a prey item or gathering within a patch and going to another prey or patch. The cost of what would be lost by continuing with one behavior at the expense of another is essentially a 'lost' opportunity, and thus a "cost" that the forager must be continuingly calculating. Related to this, discounting refers to the value of a food or object relative to time. Generally, foragers assign "a future reward less value than if it were available immediately and with certainty" (Kennett and Winterhalder 2006: pg. 12). Finally, risk-sensitive behavioral models assume a more realistic outlook on optimal returns, by using information about long-term returns and taking into account the possibility of periods of less than average return. These concepts are all important to the HBE models, but opportunity cost and marginal valuation are "at the heart of behavioral ecology models", as they are central to the foragers decision-making process (Kennett and Winterhalder 2006).

These models have a number of key features: the alternative set, constraints, a currency, and a goal. The alternative set is "the range of possible behavioral actions" that a forager may employ, and constraints are environmental or social limits that "structure resource selection opportunities". The currency is a certain measure used to "assess costs and benefits", such as the number of calories gathered, or the weight of meat obtained from hunting a particular animal rather than another (Kennett and Winterhalder 2006). In all HBE models the goals of foraging may vary, but following evolutionary theory the ultimate goals are typically optimizing or energy maximizing foraging behaviors.

Foraging theory models are optimization models, and they assume that animal behavior is adaptive, and that adaptive foraging behaviors are those that return the maximum amount of nutrients possible with as little effort expended as possible (Grayson 2001). There are numerous foraging theory models which can be used to study foraging behavior: the diet breadth or resource selection model (prey choice), the patch choice model, the patch residence time/marginal value theorem, the ideal free distribution model, the central place foraging model, and the settlement relocation model (Kennett and Winterhalder 2006). To examine resource depression, models addressing decisions of prey choice are used (Grayson 2001; Butler 2000).

The underlying assumption of the prey choice model is that during a foraging excursion, the predator is not seeking a specific prey item; they are simply looking for any and all prey, and that these prey items are randomly distributed throughout the environment (Grayson 2001). However, in the real world this is rarely the case, and prey are distributed unevenly, in what ecologists refer to as 'patches'. Upon encountering a prey item or entering a patch, the forager must decide to pursue that item or disregard it and keep looking for another item with potentially a greater return, or must decide to keep foraging in this patch or leave and go to a new patch (Kennett and Winterhalder 2006). A typical approach is to analyze prey choice based on habitats that different prey occupy (Butler and Campbell 2004). For example, a coastal patch would encompass marine foods, while an inland patch would encompass terrestrial foods, since these organisms are not distributed randomly throughout the overall environment, but are randomly distributed within their specific patches.

The prey choice model stipulates that the most efficient method of foraging is to obtain the largest prey items, since this yields the best return rate for a foraging excursion (Grayson 2001). The larger, more desirable prey items are termed "high ranked prey", in comparison to a smaller bodied animal, which is "low ranked prey" (Butler and Campbell 2004). The model suggests that when high ranked prey are encountered, these animals will be taken in preference to the low ranked prey. Only when harvesting results in a depletion of high ranked prey will the forager begin taking more of the low ranked prey (Butler 2001). The decline in population density is termed resource depression (Butler and Campbell 2004).

There are difficulties associated with using foraging theory models to study human behavior. Kelly (2007) shows that these models are typically unsuccessful at correctly predicting human foraging behaviors; however, they are successful in some studies. If an archaeologist is fortunate enough to work in an area with a continuity of prehistoric foraging groups to living foraging groups, oral history and ethnographic accounts can allow for better modeling of prehistoric subsistence strategies.

The biggest drawback to applying foraging theory to human groups is that it cannot model learned behavior of foragers (Stephens and Krebs 1986). Humans learn and pass on knowledge to offspring; the knowledge of foraging groups living in the same geographic area over a long period of time may expand and allow them to more efficiently exploit resources through time and may eliminate prey or patches from the diet. Technological innovations (e.g., fish weirs and hunting with dogs) and mass capture strategies (e.g., netting of fish) are also difficult to model. These new conditions would change some of the assumptions of the foraging models. Archaeologists using foraging theory to model prehistoric subsistence strategies can expect for deviations from model predictions to occur (Kennett and Winterhalder 2006). While these models have shortcomings, they are still a very useful tool to archaeologists.

Part 2: Quantitative Analysis Using Foraging Theory Models

This study uses four hypotheses proposed by foraging theory to test for resource depression with archaeological data.

Hypothesis 1: Resource depression leads to a decline in high ranked species and an increase in low ranked prey.

To analyze the high ranked versus low ranked species in the diet, a prey index is used (Morrison and Hunt 2007, Nagaoka 2002). The prey index uses the equation:

$$\Sigma \text{ large taxon}/\Sigma \text{ (large taxon+small taxon)}.$$

This index compares the relative abundance of the large, high ranked taxon to the small, low-ranked taxon. Calculation with the index results in a value between 0 and 1, with 0 indicating assemblage consists entirely of the small taxon and 1 that the assemblage consists entirely of the large taxon. To analyze for change over time, an index value is calculated for each temporal period under study and the changes through time are tested for significance using a Chi-square. A significant decrease in the prey index value through time shows an increase in the amount of low-ranked prey in the diet and can be used as an indicator of resource depression.

Hypothesis 2. Resource depression results in a widening of diet breadth to include more diverse and general resources.

Diet breadth is examined using two methods: identifying the number of taxa (NTAXA) in the diet and determining the evenness (E) of the diet (Morrison and Hunt 2007). The evenness measures the relationship between proportions of species in the diet to determine if a diet was focused or generalized. Evenness is measured using the equation:

$$-\Sigma \, (p_i \log[p_i])/\log(\text{NTAXA})$$

(Butler 2001). An on-line version of an evenness calculator simplifies the calculation of this equation, providing a resulting value between 0 and 1 (http://www.changbioscience.com/genetics/shannon.html). A value of 0 indicates that a large proportion of the assemblage is dominated by a small number of taxa, and value of 1 indicates that the proportions of all the taxa within the assemblage are equal to each other. An increase in NTAXA and E over time indicates the exploitation of more species and increasing generalization within the diet. To test for the significance of changes in these values through time, a one-way ANOVA test is used. An ANOVA test analyzes the variation within a group and between two or more groups to determine if means of these groups are significantly different (Drennan 2009). I used SPSS v. 18 to perform the ANOVA tests. If the increases in NTAXA and E values are significant, this is an indication of resource depression.

Hypothesis 3. Resource depression results in decreases in individual prey size and age.

I used the size of fish bones as a proxy for live body size; since fish growth is continuous throughout an individual's lifespan, larger older individuals will have larger bones (Broughton 1997). Studies have shown that fish under high harvest pressure from humans show a reduction in body size through time as the larger adults are methodically removed from the population (Conover et al. 2009). To analyze body size, the same skeletal element of a taxon is measured and the average size for each temporal period is determined. An ANOVA is used to determine if the change in mean size is significant. A significant decrease in the average size of fish through time is an indicator of resource depression.

In summary, to see unequivocal evidence for resource depression in the archaeological record, the following conditions must be seen in the results of the data analysis:

1. Prey Index-the value must decrease significantly through time
2. Evenness-the value for identified fish must increase significantly through time
3. NTAXA-the number of identified species must increase significantly through time
4. Size of fish-the average size of fish must decrease significantly through time.

Part 3: Laboratory Analysis of Ichthyofaunal Remains

During the summers of 2007, 2008, and 2009, the Hawaiian Archaeological Research Project (HARP) conducted archaeological excavations along the coast and within the LKFS in

Kohala, Hawai‘i. Artifacts, including fish and mammal bone, mollusk shell, plant remains, and lithics, collected during excavation were bagged, and the provenience information was recorded on each bag. Provenience is the object(s) location in the excavation unit, providing archaeologists the context within which interpretation of use or function of an artifact(s) can be performed. For example, the provenience number MKI-56-TU1-8-2 indicates that the artifact comes from the Makiloa *ahupua‘a*, feature #56, test unit #1, level #8, and this is bag #2. The majority of the material was brought back to Dr. Field’s laboratory for sorting and analysis. After the preliminary analysis was finished, all fish bone had been bagged separately from the other material.

I first identified all the fish skeletal remains (ichthyofaunal remains) to the taxonomic level of family. While identification to species is desired for zooarchaeological studies, fish skeletal remains are difficult to identify beyond the family level (Wheeler and Jones 1989). Since fish have the same basic anatomy (Figure 3.1), there are a small number of bones which can be used for identification purposes. Five jaw bones, including the maxilla, dentary, premaxilla, angular (or articular bone) and quadrate are the most diagnostic of family level, as are other specialized bones that are particular to certain genera and species. For example, the pharyngeal plates of *Labridae* spp. and *Scaridae* spp. and the first and second dorsal spines of *Balistidae* spp. and *Monacanthidae* spp. (see Figure 3.2).

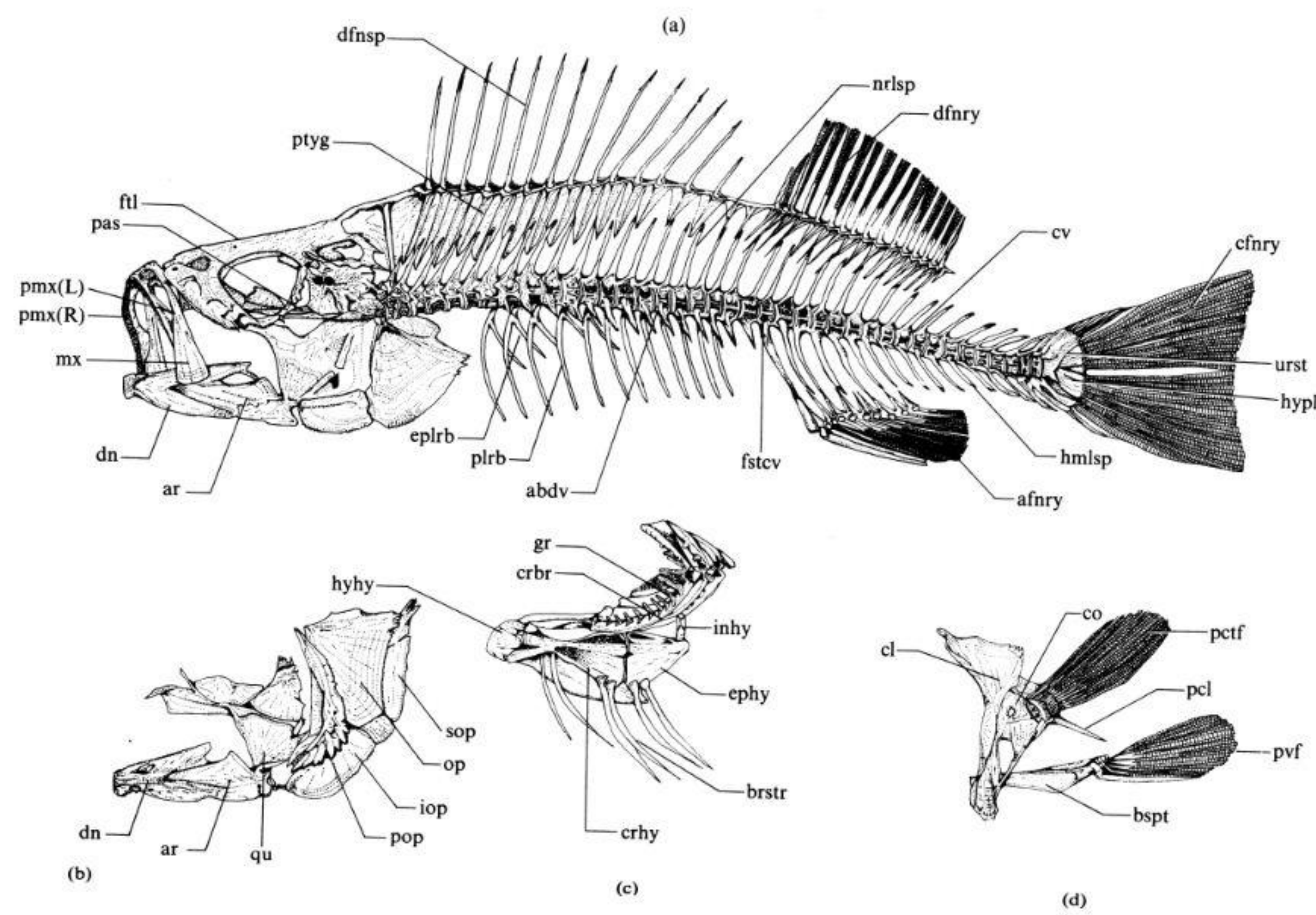
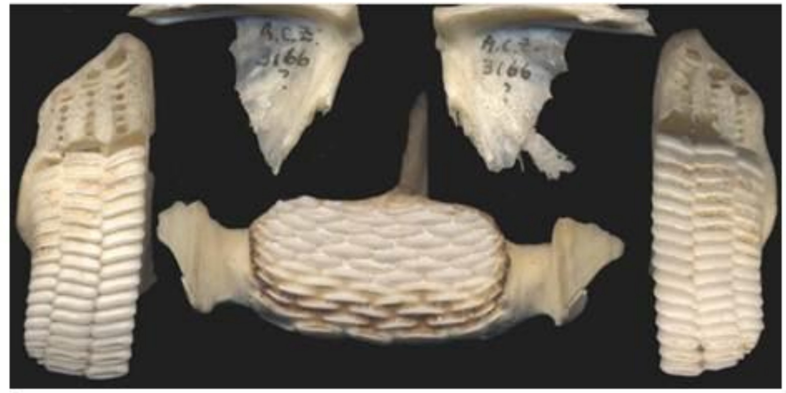


Figure 3.1. The general skeletal anatomy of bony fish (Wheeler and Jones 1989: pg. 88).

Balistidae spp. first dorsal spine

*Monacanthid*ae spp. first dorsal spine

Labridae spp. lower pharyngeal plate (Dye and Longenecker 2004: pg. 47).



Calotomus sp. upper and lower pharyngeals and quadrates (Dye and Longenecker 2004: pg. 63).

*Scarus/Chloror*us sp. lower pharyngeal

Scarus/Chlorurus sp. upper pharyngeals

Figure 3.2. Examples of “special bones” of fish. (Photos by J. Lipphardt unless otherwise indicated).

I first sorted through all the ichthyofaunal material in the laboratory, and I collected each element that could be later identified. I placed each element in a plastic bag labeled with provenience information. After I sorted through all the ichthyofaunal material, I started the process of identification.

To identify the material, I used the reference collection of modern Pacific fish available in Dr. Field's laboratory, and Dye and Longenecker's (2004) *Manual of Hawaiian Fish Remains Identification Based on the Skeletal Reference Collection of Alan C. Ziegler and Including Otoliths*. I also compiled a digital reference database, which was useful for quickly locating pictures of certain taxa or elements. This database can also be shared with other archaeologists, and could potentially be used for field identification. I photographed all the material from Dr. Field's reference collection, and used the photographs from Dye and Longenecker (2004) to create a larger reference collection for in-lab usage. I used a paper form to record different attributes of each skeletal element, including identification, element side (right or left), and measurements of length (see Appendix 1 and 2). All data were entered into a Microsoft Access database.

To perform the statistical analyses discussed above, I quantified the remains from each excavation level using NISP and MNI (Grayson 1984). NISP is the number of identified specimens, or the count of all elements from one family in a level. For example, if 5 right angulars, 6 lower pharyngeals and 2 left maxilla of *Scaridae* spp. were identified, the NISP would be 13 (5+6+2). MNI is the minimum number of individuals identified from a family. Using the above example, the MNI would be 6. Since each Scarid only has one lower pharyngeal, the 6 identified must have come from at least 6 fish. There may have been more angulars and maxillas present, but these may have become fragmented to the point that they are now unidentifiable. NISP tends to overestimate the actual number of individuals present in an assemblage, while MNI can underestimate it. I decided to record both of these categories so I could compare the results of my statistical analyses from both these methods of quantification.

Chapter 4: Results

The faunal material analyzed here was generated from the excavation of sixty-six units. For a detailed description of each site and the excavations, see Field et al. 2008, 2009, 2010a. The deposits within the excavation units were assigned to a temporal period based on the results of radiocarbon dating of organic material recovered from the fill. Seventeen of the units under analysis did not contain material that could be utilized in radiocarbon dating; these were not included in the following statistical analyses. Identifiable fish remains were present in 49 excavation units (Figure 4.1, Appendix 3). Of these 49 units, 11 did not have radiocarbon dates and were not included in the statistical analysis.

In Part 1, I will first present the results of the identification of the ichthyofaunal assemblage. This will be done by *ahupuaʻa*, in alphabetical order, and in chronological order within *ahupuaʻa*. Since the identified assemblage from each excavation unit was small, units that dated to the same temporal period within each *ahupuaʻa* were combined for the statistical analysis and discussion. Based on the results of the radiocarbon dating, the temporal periods used are AD 1400-1520 (Period 1), AD 1520-1650 (Period 2), AD 1650-1800 (Period 3), and AD 1800-present (Period 4) (Field et al. 2008, 2009, 2010a).

Part 2 contains the taxonomic rankings. Taxonomic ranking is an ordinal measure of the abundance of each identified family within an assemblage. The ranking was calculated for the combined assemblage of each temporal period within *ahupuaʻa*; these are presented in chronological order.

Part 3 contains the results of the statistical analyses for resource depression. First, the results of the prey index are given. The prey index was conducted on the combined *Scaridae* spp. and *Labridae* spp. abundances for each *ahupuaʻa* under study in Kohala. Next are the results of tests for significant change in evenness and NTAXA of the identified assemblage. Evenness and NTAXA were determined for each excavation unit, and an ANOVA test was conducted for significant change in these values through time within each *ahupua'a*. The evenness and NTAXA values were also tested for significant change for all of Kohala; the values of each *ahupua'a* of the same temporal period were combined and tested. Part 3 also contains a comparison of the use of different ocean biotic zones through time in prehistory. Finally, the results of the ANOVA tests for changes in the average size of fish through time are presented.

Part 4 presents the results of the analysis of the general faunal assemblage by comparing the abundance of fish, mollusk, mammal, and bird in the Kohalan diet through time by various means. Evenness values for each excavation unit, at the level of the general faunal assemblage were also calculated and tested by ANOVA for significant change over time. The values for each *ahupua'a* were combined to analyze change through time for Kohala. Part 4 also presents the comparison of the identified ichthyofaunal assemblages for the coastal and upland sites excavated in Kohala. The assemblages are compared by abundance (the NISP, weight, and density of fish within the entire faunal assemblage), by diet breadth (evenness and NTAXA), and by taxonomic diversity. Finally, a brief summary of the results of the entire analysis is presented.

Part 1: Results of the Analysis of the Ichthyofaunal Assemblage

A total of 84,703 fish bones were recovered from excavations in Kohala; the majority of the ichthyofaunal assemblage was highly fragmented. Of these, 395 elements were identified to family level (0.47% of the total assemblage) and were analyzed. These represent a minimum of 245 fish from 21 different taxa (Figure 4.2; see Appendix 4 for the complete table of identified elements). The results are discussed below by *ahupua'a.* Identifiable elements were recorded both as NISP (the number of identified specimens) and MNI (minimum number of individuals) for each fish taxon. Ichthyofaunal elements were identified to the family level throughout the entire analysis. The most common family identified in this assemblage was *Scaridae* spp. (NISP=114, MNI=79), followed by *Labridae* spp. (NISP=59; MNI=43), *Monacanthidae* spp. (NISP=55, MNI=29) and *Balistidae* spp. (NISP=45, MNI=33). These are all common reef fish and were known to have been utilized in prehistoric Hawai'i (Hoover 2003; Kirch 1985).

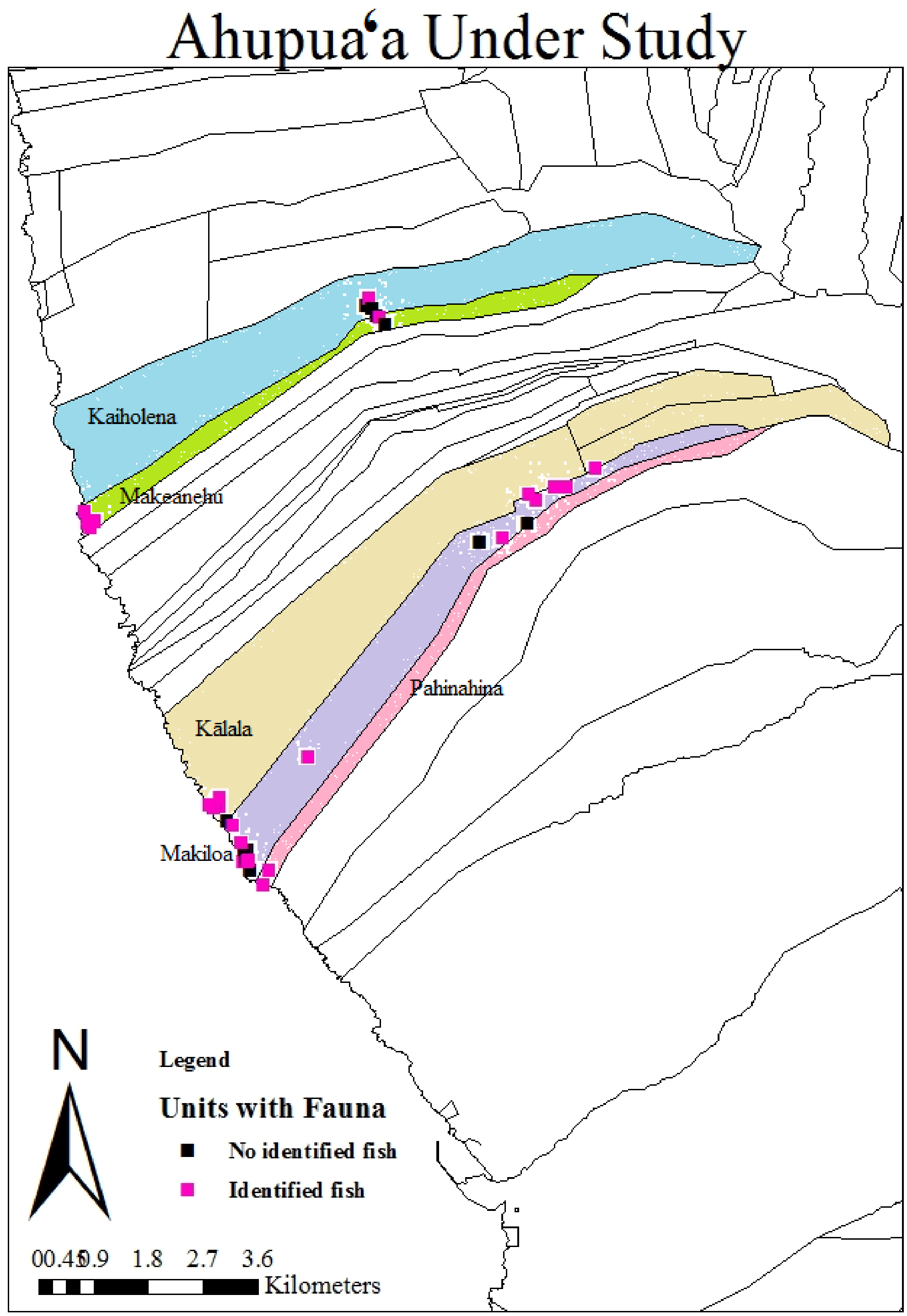


Figure 4.1. The *ahupua'a* under study in this project, showing excavation units that contained faunal material.

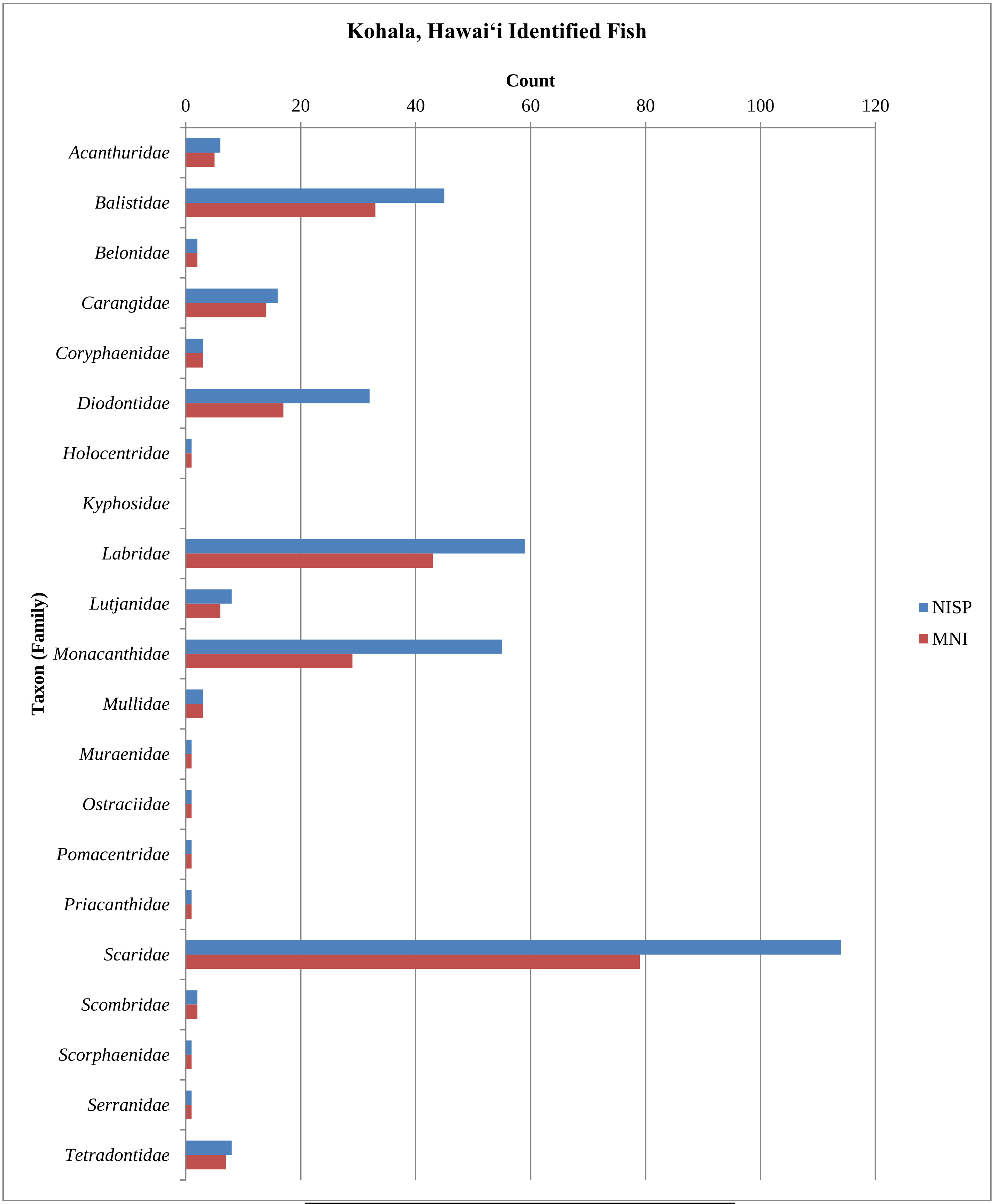


Figure 4.2. The identified fish remains from Kohala.

Kaiholena

Period 1

No excavation units from Kaiholena dated to this temporal period.

Period 2

One excavation unit yielded a total of 2 identifiable fish bones representing a minimum number of 2 individuals from 2 different taxa. This unit, KHL-2A-TU1, was part of a household complex). The identified families were *Diodontidae* spp. and *Balistidae* spp. (Figure 4.3).

Period 3

Three excavation units yielded a total of 9 identifiable fish bones representing a minimum number of 9 individuals from 6 different taxa. These units, KHL-2D-TU2, KHL-2D-TU3, and KHL-2B-TU4 were part of one household complex. The most commonly identified taxa from NISP and MNI calculations was *Scaridae* spp. (see Figure 4.4).

Period 4

No excavation units from Kaiholena dated to this temporal period.

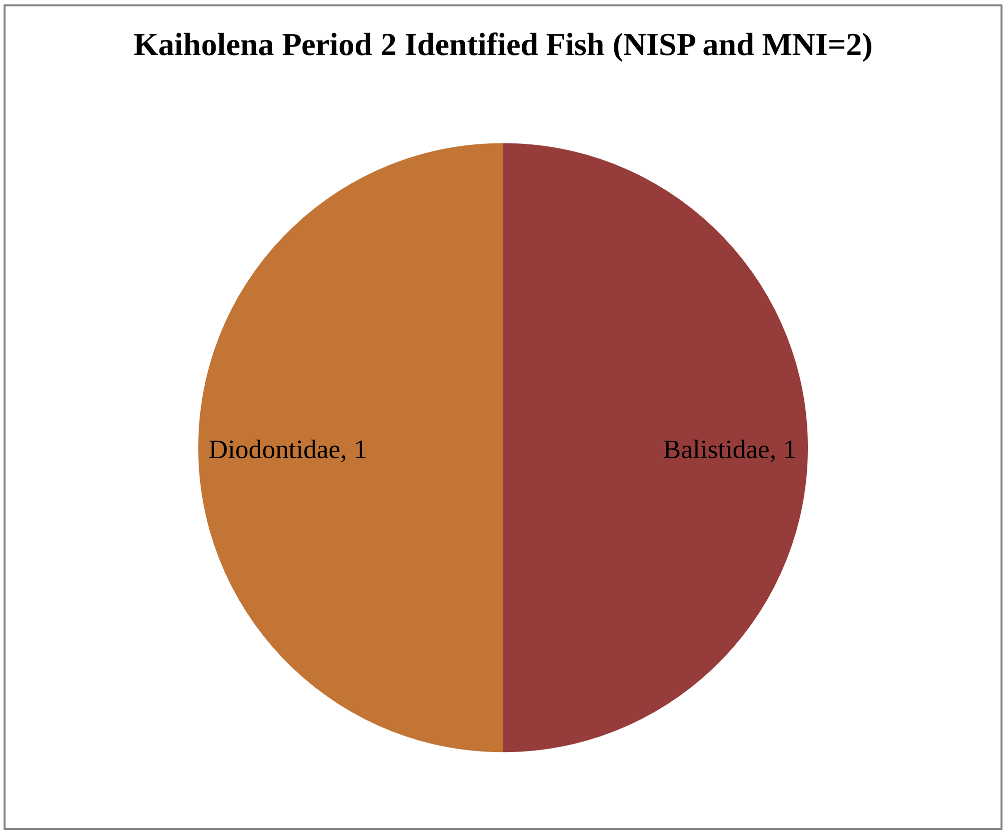


Figure 4.3. NISP and MNI of identified fish from Kaiholena, period 2.

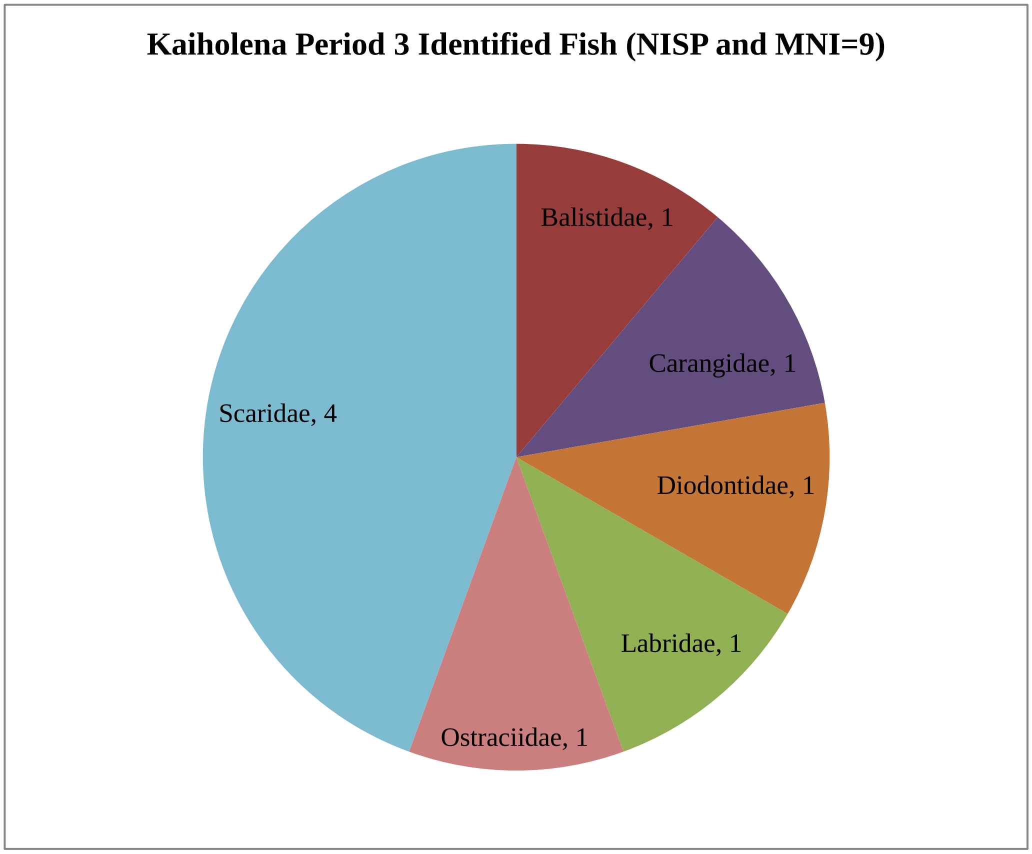


Figure 4.4. NISP and MNI of identified fish from Kaiholena, period 3.

Kālala

Period 1

No excavation units from Kālala dated to this temporal period.

Period 2

One excavation unit yielded a total of 3 identifiable fish bones representing a minimum number of 3 individuals from 3 different taxa (Figure 4.5). No dominant taxa could be identified. This unit, KAL-30A-TU1, was part of a household complex

Period 3

Two excavation units yielded a total of 50 identifiable fish bones representing a minimum number of 29 individuals from 10 different taxa (Figure 4.6a and 4.6b). One unit (KAL-5A-TU1) was part of a household complex; the other (KAL-30B-TU2) was located in within a ritual structure. Using NISP calculations, the ichthyofaunal assemblage was dominated by *Diodontidae* spp. However, members of *Diodontidae* spp. have a large number of bony spines that other fish families do not have; the domination of the assemblage by *Diodontidae* spp. was likely inflated by a large number of broken spines. When using MNI calculations, *Diodontidae* spp. and *Scaridae* spp. are in equal abundance to each other (n=6).

Period 4

Eight excavation units yielded a total of 37 identifiable fish bones representing a minimum number of 28 individuals from 9 different taxa (see Figure 4.7a and 4.7b). All units, KAL-10A-TU1, KAL-10A-TU2, KAL-10B-TU3, KAL-10C-TU4, KAL-10C-TU5, KAL-10C-TU6, KAL-23A-TU3, and KAL-23B-TU2, were placed in household complexes. Using NISP and MNI calculations, the assemblage was dominated by *Scaridae* spp., followed by *Labridae* spp.

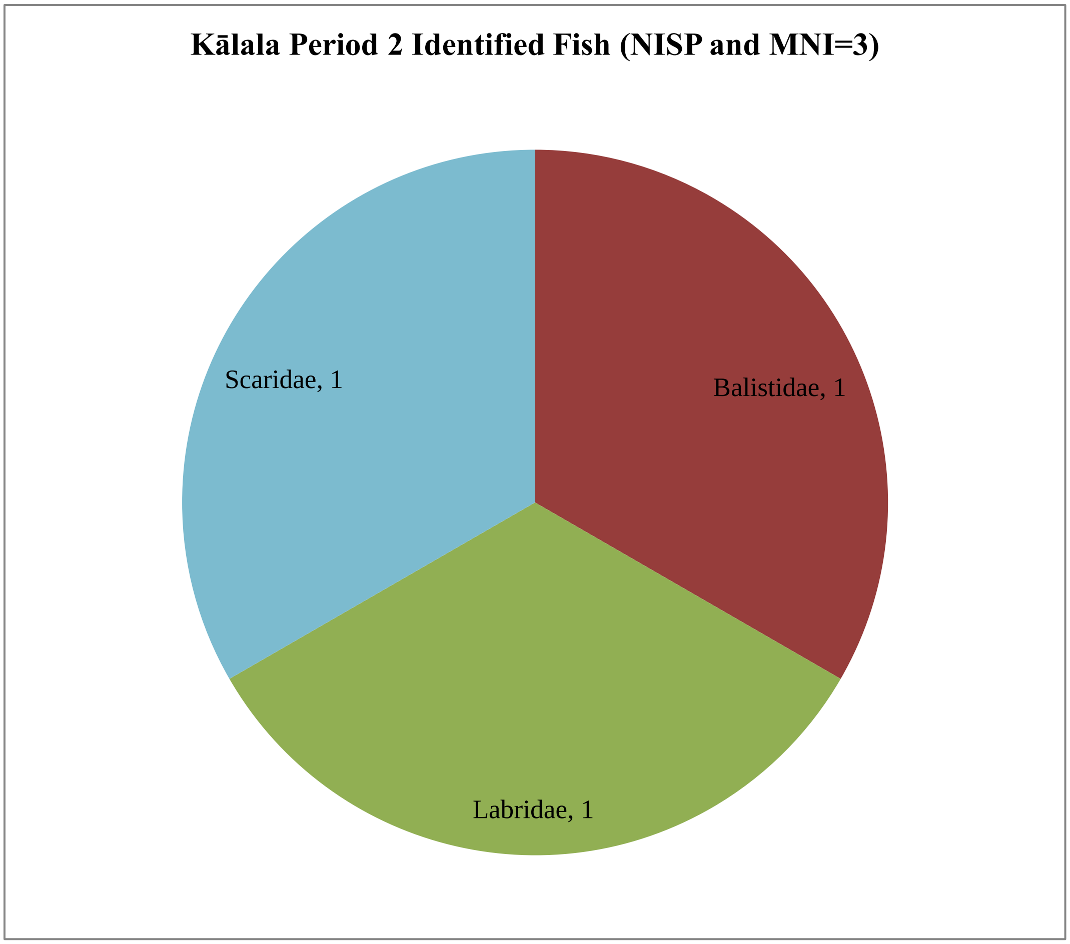


Figure 4.5. NISP and MNI of identified fish from Kālala, period 2.

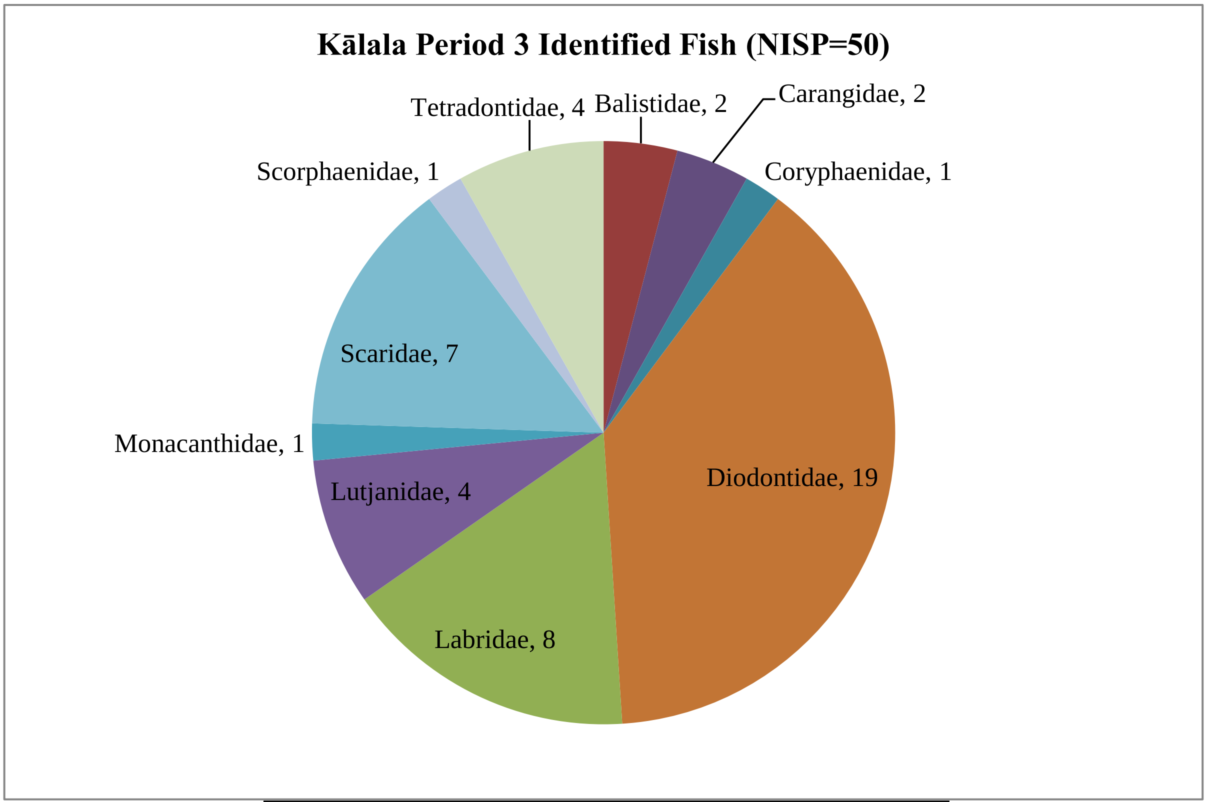


Figure 4.6a. NISP of identified fish from Kālala, period 3.

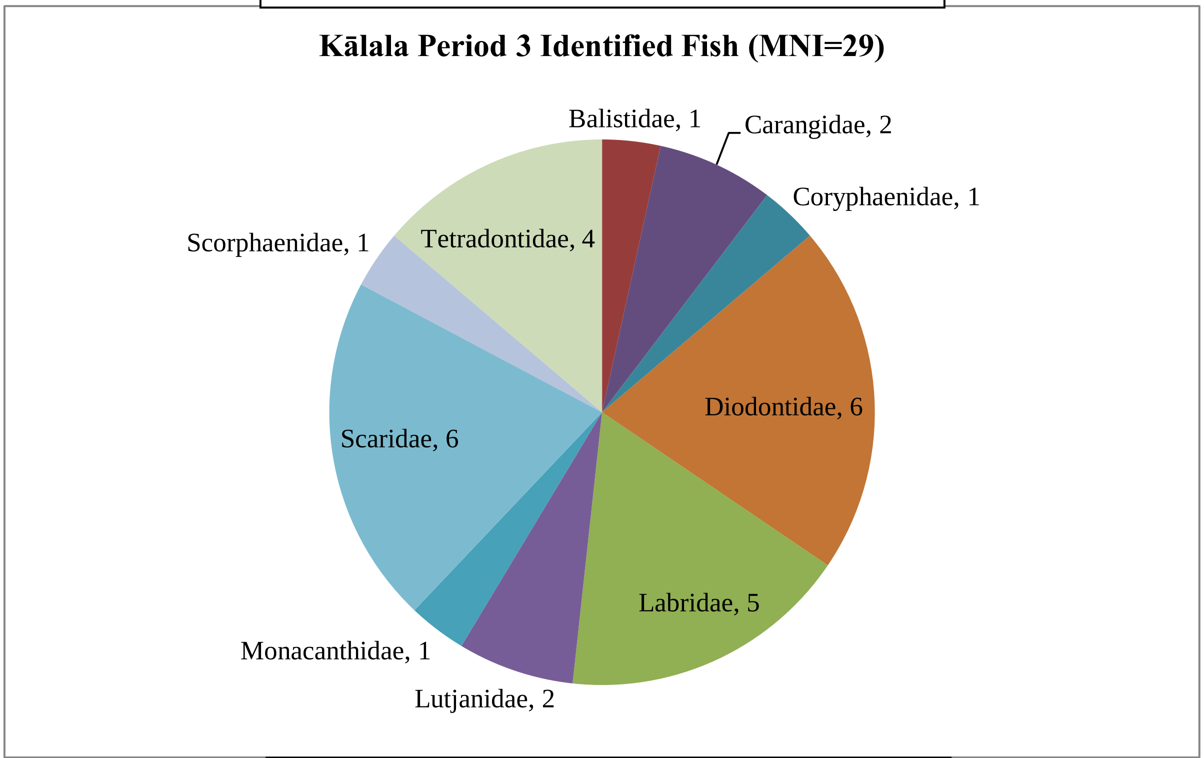


Figure 4.6b. MNI of identified fish from Kālala, period 3.

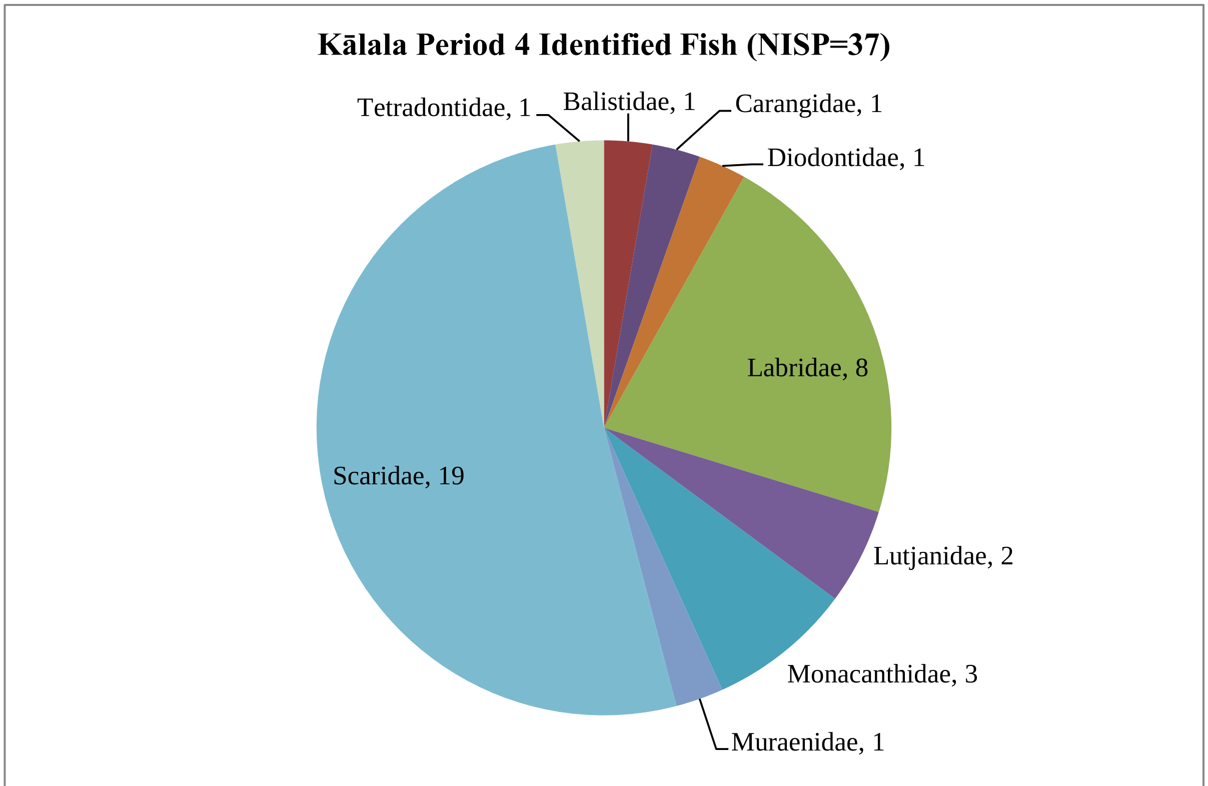


Figure 4.7a. NISP of identified fish from Kālala, period 4.

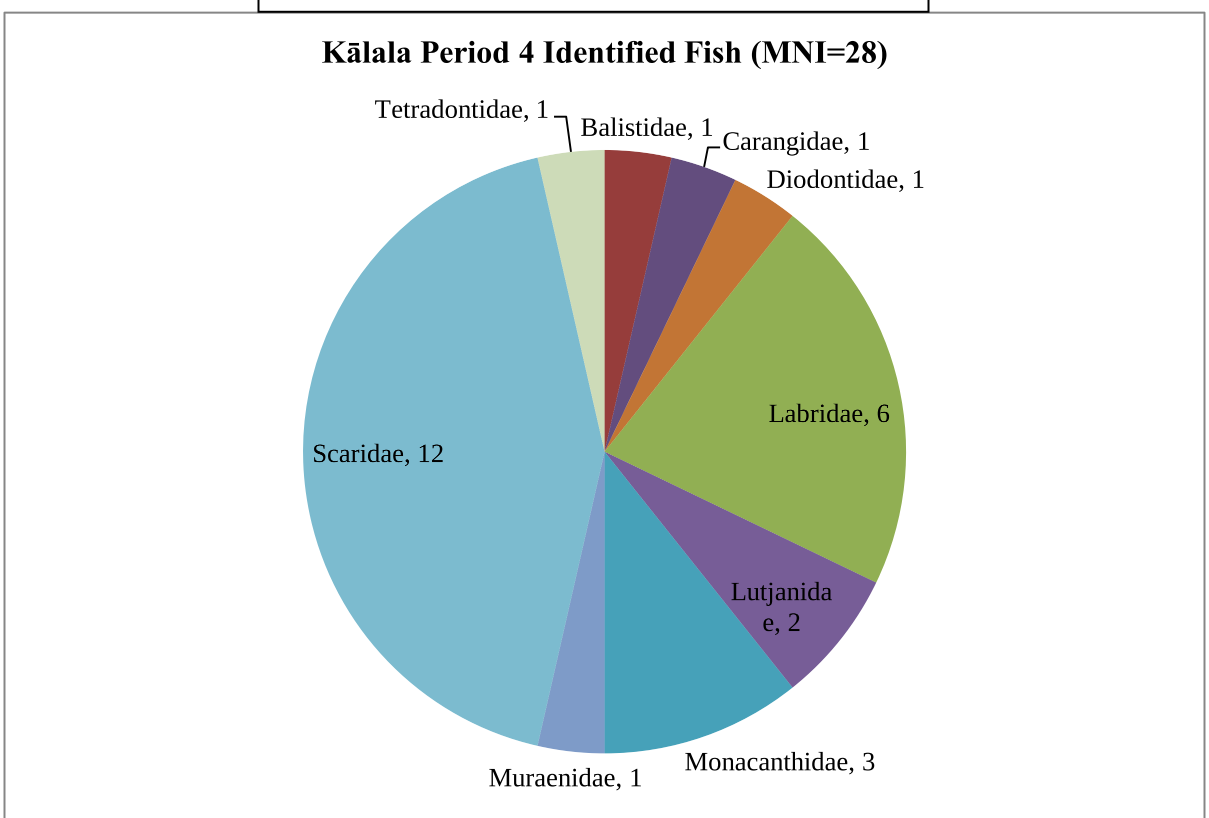


Figure 4.7b. MNI of identified fish from Kālala, period 4.

Makeanehu

Period 1

One excavation unit yielded a total of 2 identifiable fish bones representing a minimum of 2 individuals from 2 different taxa (Figure 4.8). This unit, MKE-106-TU1, was part of a household complex

Period 2

Three excavation units yielded a total of 17 identifiable fish bones representing a minimum number of 14 individuals from 6 different taxa (Figure 4.9a and 4.9b). These excavation units, MKE-103-TU1, MKE-104-TU1, and MKE-105-TU1, were all located in household complexes. The most commonly identified taxa were *Monacanthidae* spp., followed by *Scaridae* spp. and *Balistidae* spp..

Period 3

One excavation unit, MKE-108A-TU1, yielded a total of 36 identifiable fish bones representing a minimum number of 11 individuals from 4 different taxa (Figure 4.10a and 4.10b). The assemblage contained many small fragments of *Monacanthidae* spp. first dorsal spines, which highly inflated the NISP of this taxon in the identified assemblage. Using MNI calculations, it is still the most commonly identified taxon, but is in more equal proportion to the other taxa in the assemblage.

Period 4

No excavation units from Makeanehu dated to this temporal period.

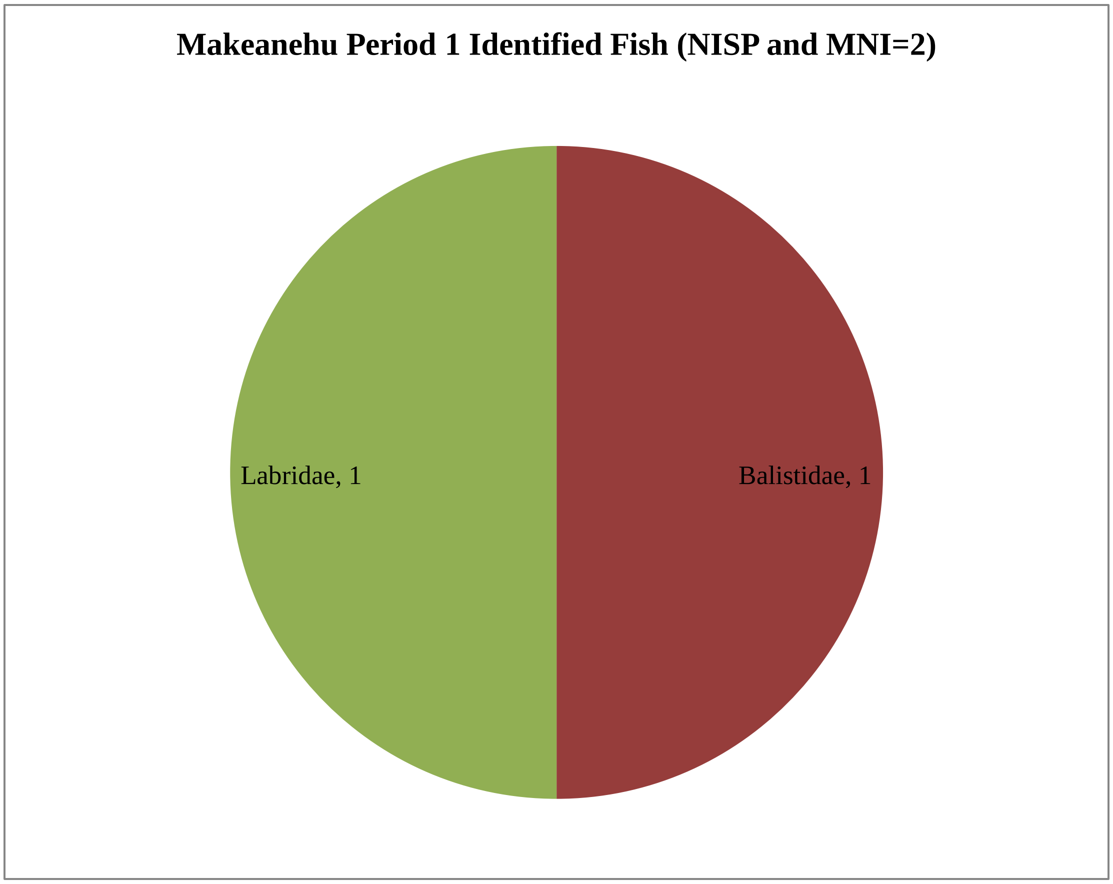


Figure 4.8. NISP and MNI of identified fish from Makeanehu, period 1.

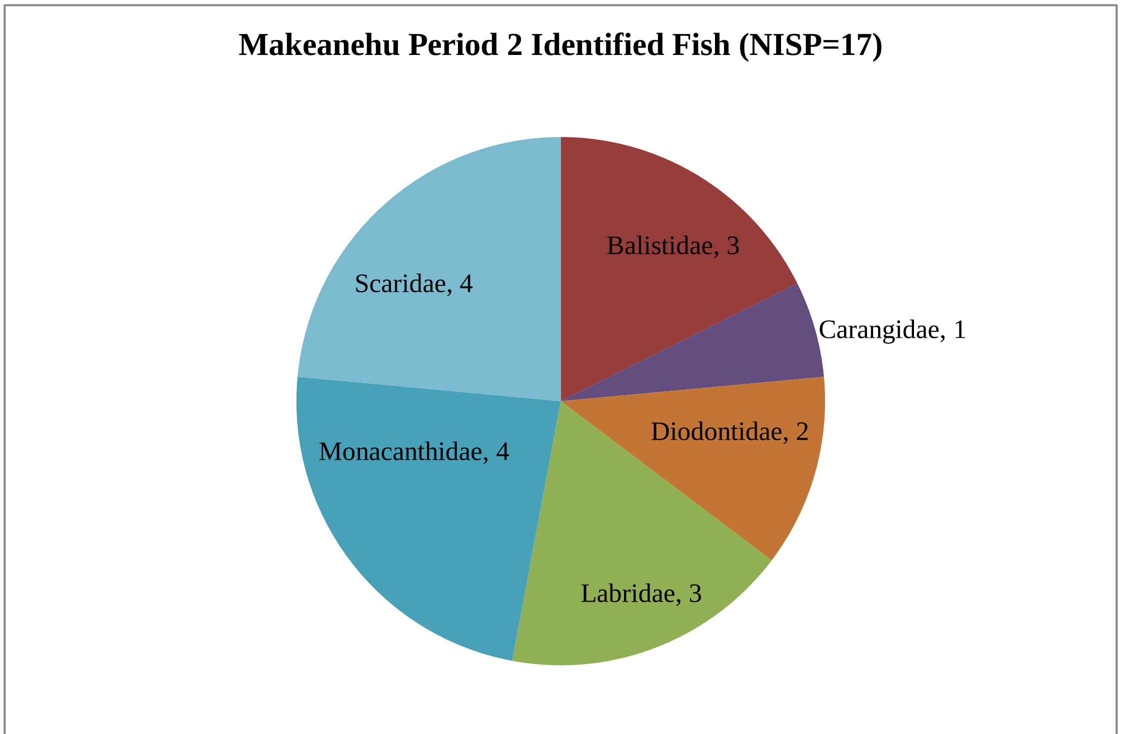


Figure 4.9a. NISP of identified fish from Makeanehu, period 2.

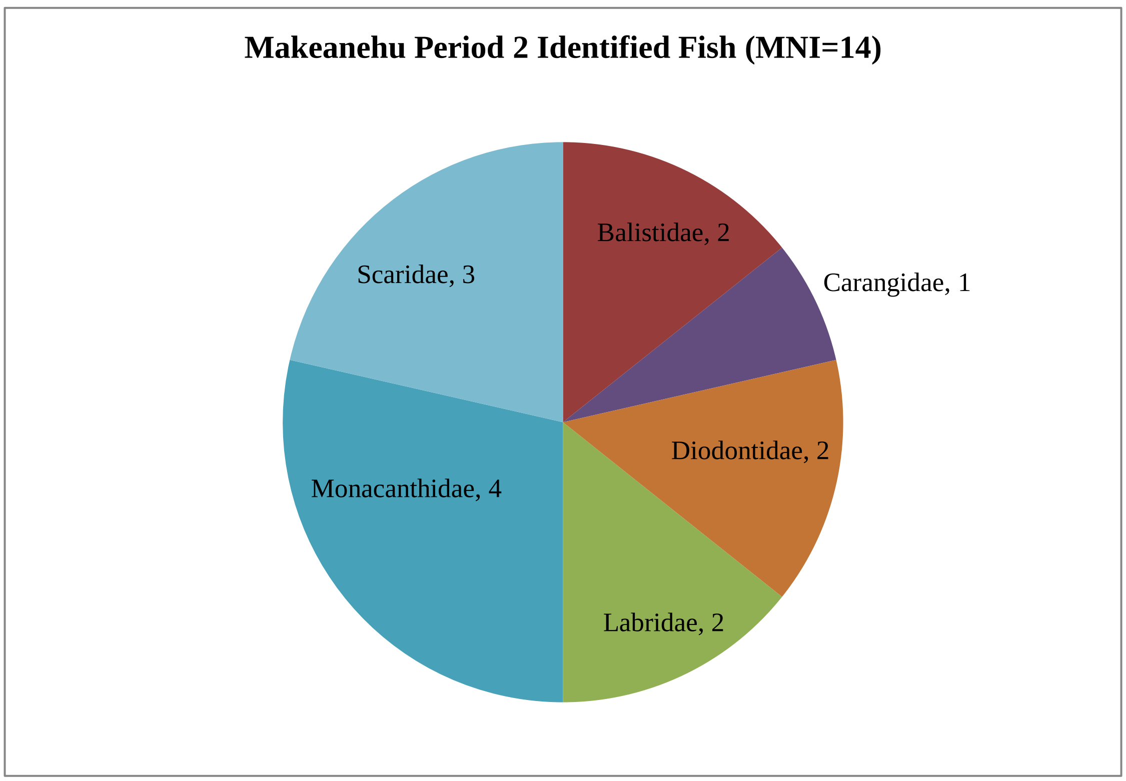


Figure 4.9b. MNI of identified fish from Makeanehu, period 2.

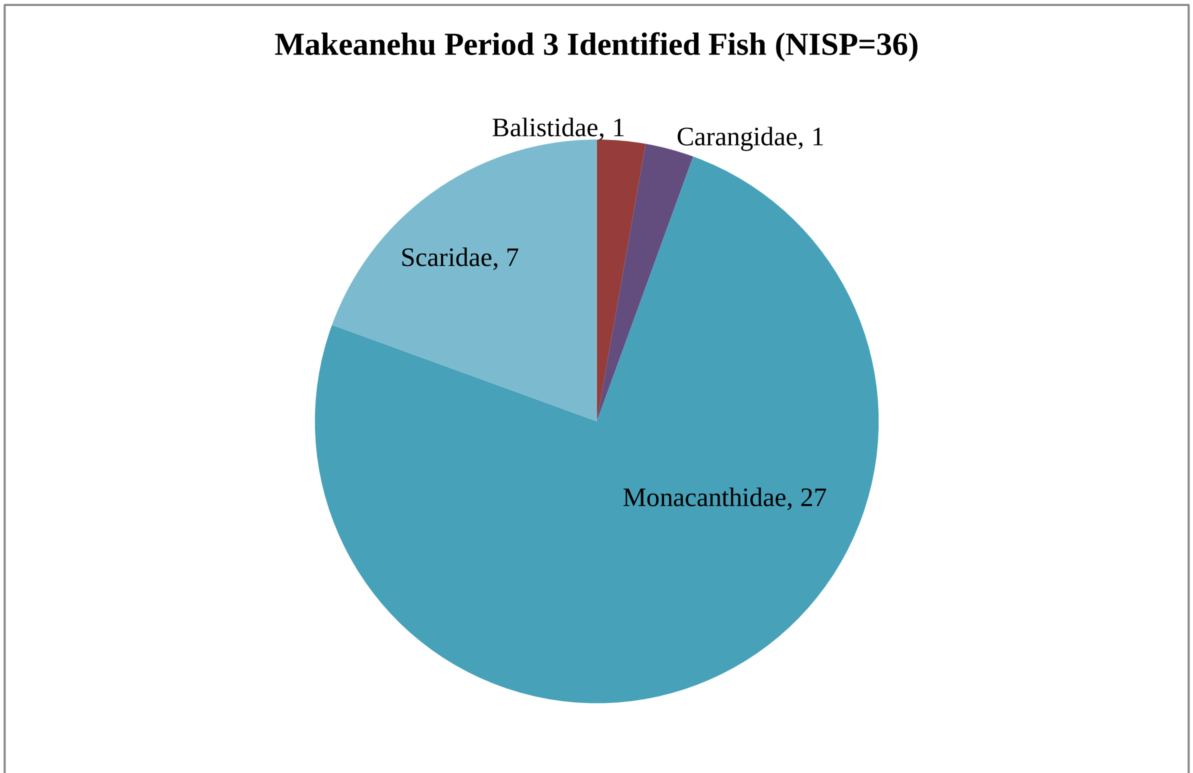


Figure 4.10a. NISP of identified fish from Makeanehu, period 3.

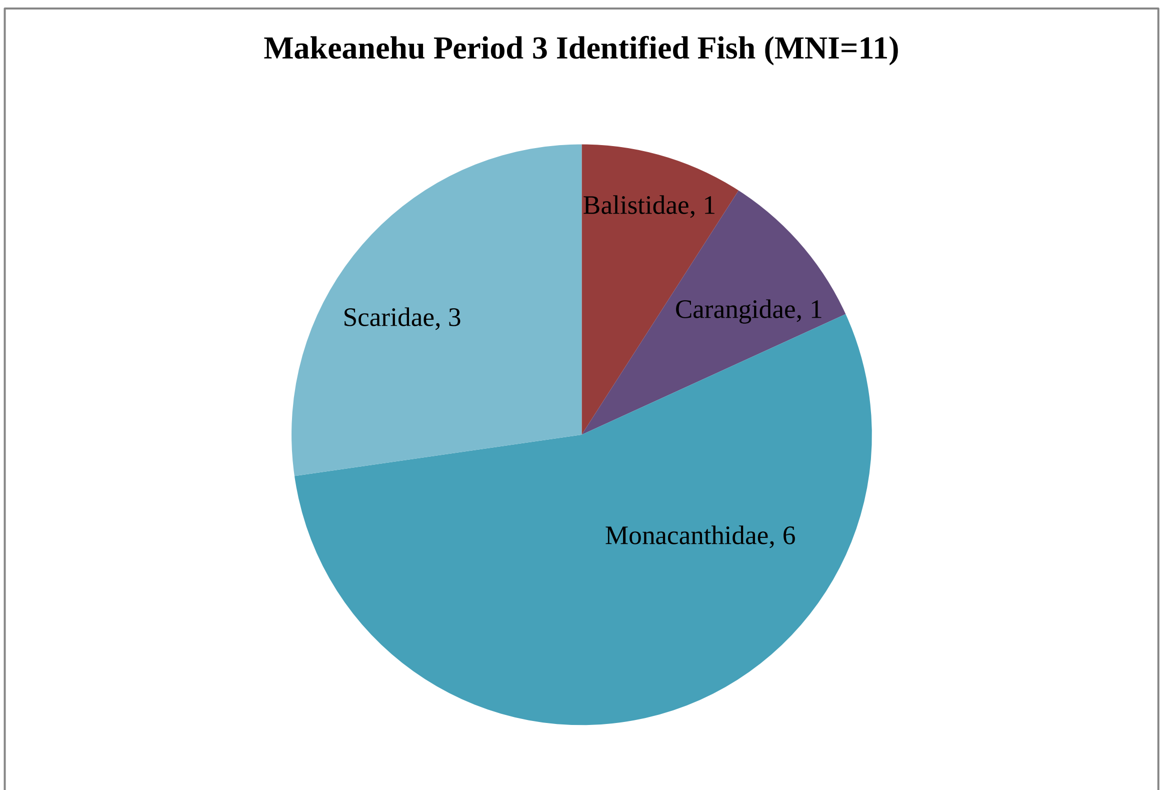


Figure 4.10b. MNI of identified fish from Makeanehu, period 3.

Makiloa

Period 1

One excavation unit yielded a total of 4 identifiable fish bones representing a minimum of 4 individuals from 2 different taxa (see Figure 4.11). This unit, MKI-303-TU1, was part of a household complex.

Period 2

Three excavation units, MKI-378A-TU1, MKI-2A-TU2, AND MKI-301A-TU2, yielded a total of 46 identifiable fish bones representing a minimum of 25 individuals from 5 different taxa (Figure 4.12a and 4.12b). The assemblage was dominated by *Scaridae* spp. (over 50% for both NISP and MNI calculations).

Period 3

Eleven different excavation units yielded a total of 113 identifiable fish elements representing a minimum of 93 individuals from 15 different taxa (see Figure 4.13a and 4.13b). Nine of the excavation units, MKI-11A-TU1, MKI-1A-TU1, MKI-23A-TU1, MKI-25B-TU3 MKI-2C-TU3, MKI-300-TU1-MKI-301A-TU1, MKI-304A-TU1, MKI-306-TU1, MKI-414-TU1, were from household complexes, but one unit was placed in a primary household/ritual complex (*heiau*). This unit (MKI-56-TU1) contained the most identifiable elements of any excavation unit (NISP=51, MNI=34; see Appendix 4).

The most commonly identified taxa for both NISP and MNI calculations were *Scaridae* spp., *Balistidae* spp., *Labridae* spp., *Monacanthidae* spp. and *Carangidae* spp. Period 3 has the greatest amount of bone and highest number of taxa identified throughout the complete ichthyofaunal assemblage. The MKI-56 excavation unit may have inflated this number, since the unit did contain a large amount of fish bone. It is likely that the inhabitants of this unit were involved in intensive fishing activities; this is indicated by the presence of fish hooks in the artifact assemblage (Field et al. 2009). However, when looking at the identified assemblage without this unit under analysis, the number of fish taxa present in the assemblage only decreases by one (*Priacanthidae* spp. is only present in MKI-56). The patterns of exploitation at this complex do not differ significantly from the rest of Makiloa for this period (p=.492).

Period 4

No excavation units from Makiloa dated to this temporal period.

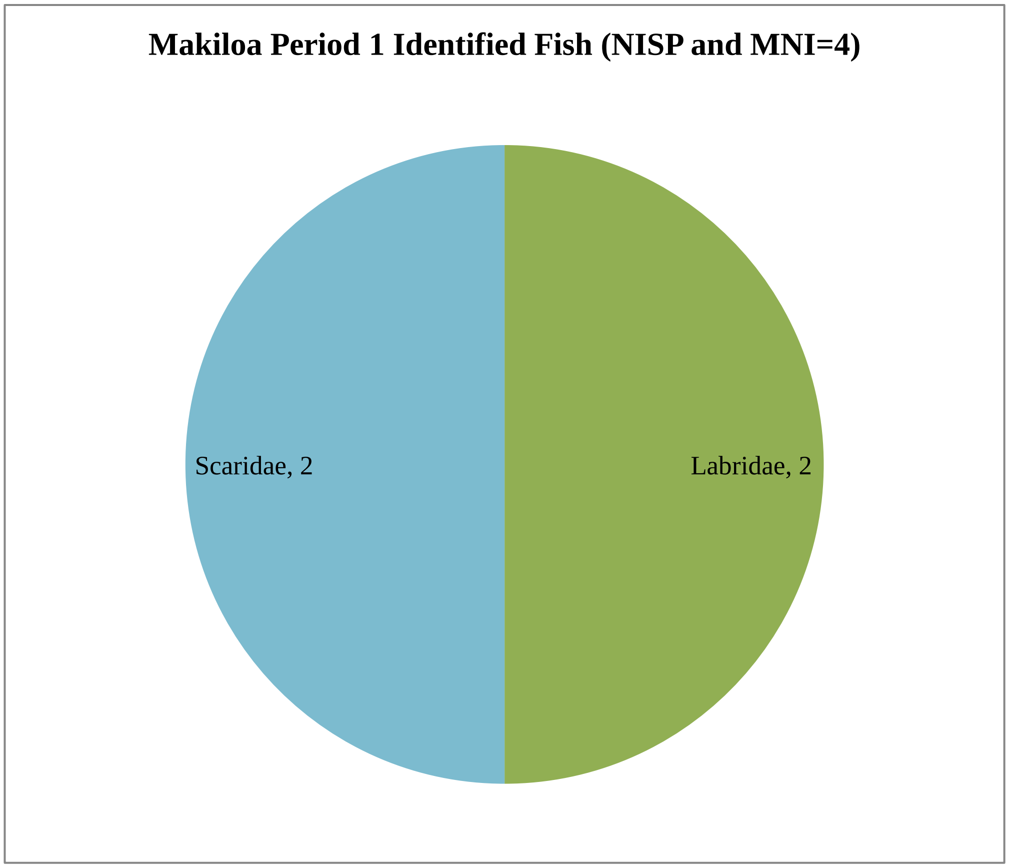


Figure 4.11. NISP and MNI of identified fish from Makiloa, period 1.

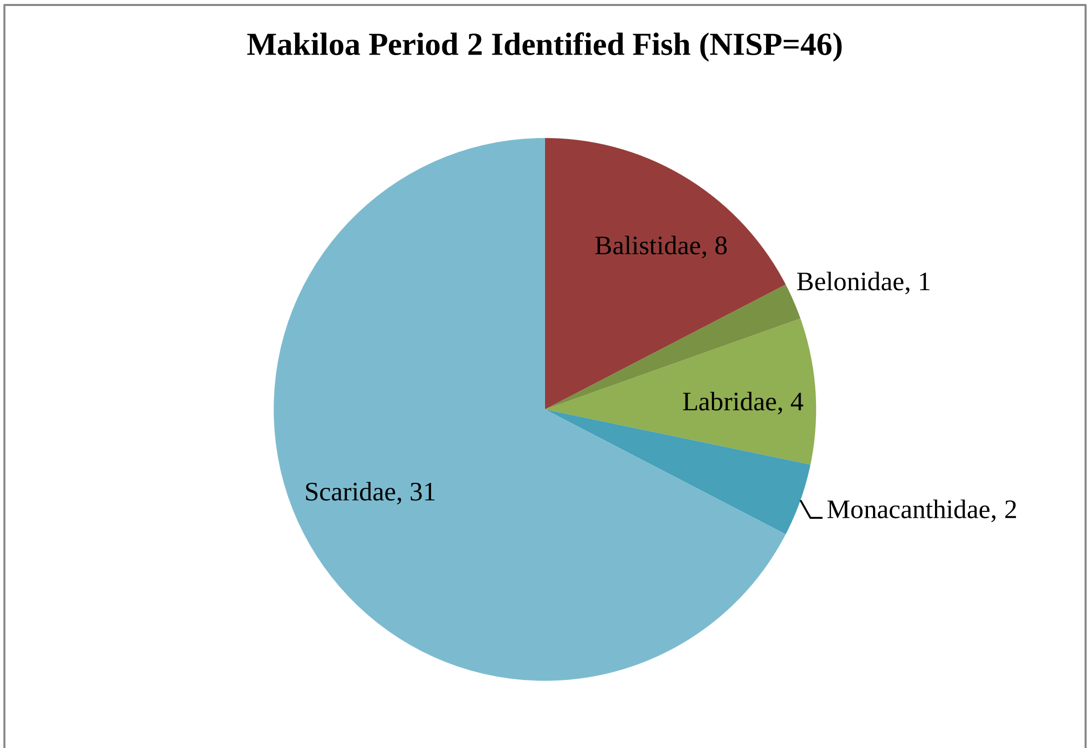


Figure 4.12a. NISP of identified fish from Makiloa, period 2.

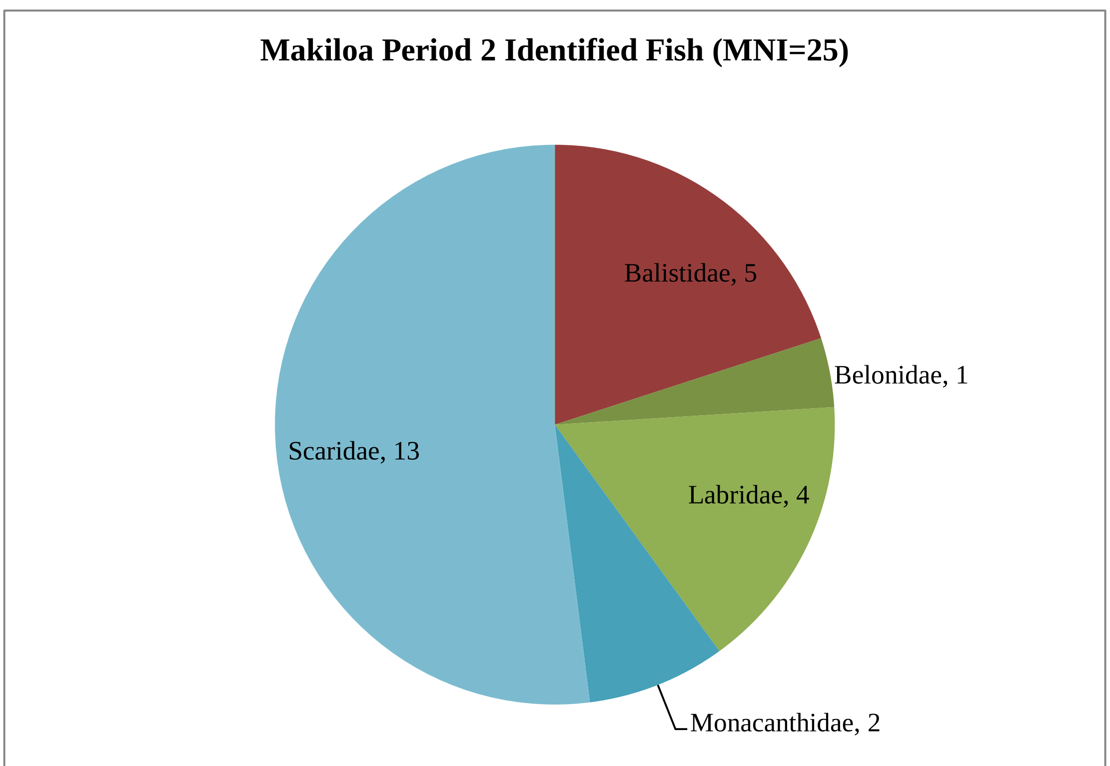


Figure 4.12b. MNI of identified fish from Makiloa, period 2.

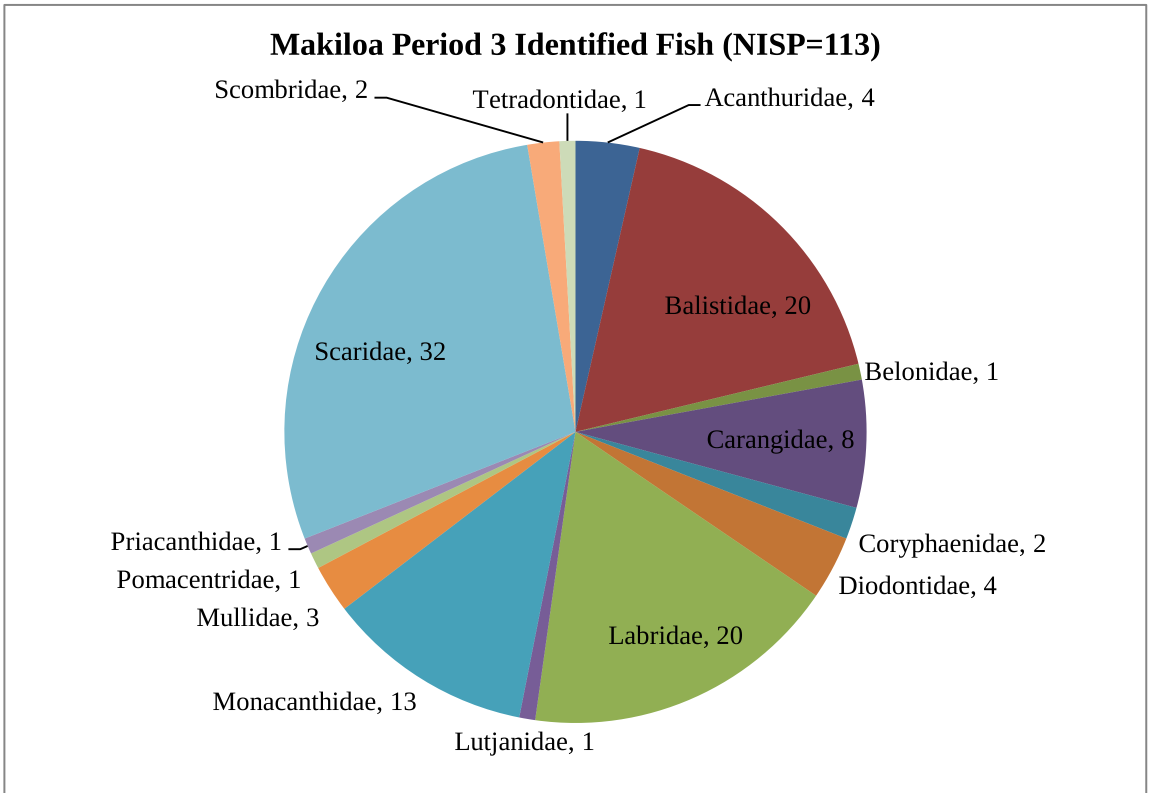


Figure 4.13a. NISP of identified fish from Makiloa, period 3.

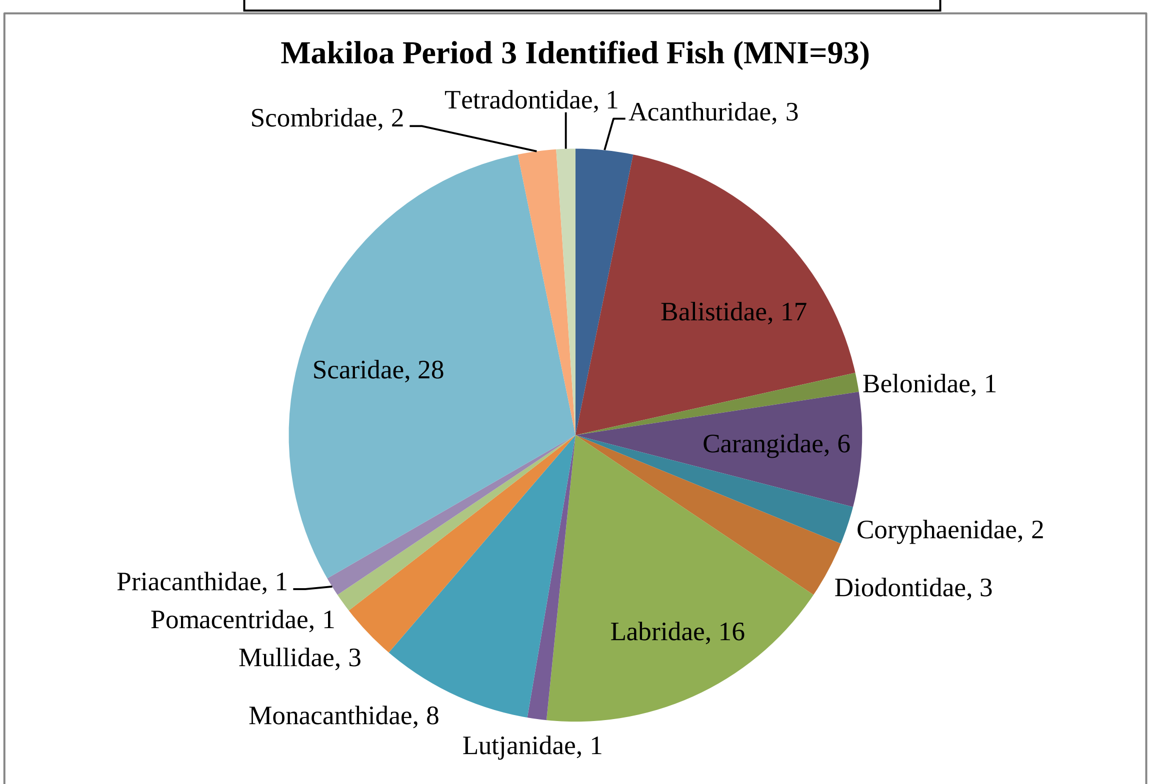


Figure 4.13b. MNI of identified fish from Makiloa, period 3.

Pahinahina

Period 1

Two excavation units from Pahinahina yielded a total of 42 identifiable fish bones representing a minimum of 30 individual fish from 11 different taxa (Figure 4.14a and 4.14b). Both test units, PHH-13A-TU1 and PHH-30-TU1, were identified as household structures. However, the PHH-13A complex may be a ritual structure (Field, personal communication).

The most commonly identified taxa were *Labridae* spp. when using NISP, and *Scaridae* spp. when using MNI. Three additional taxa contributed approximately 10% or more to the assemblage, using NISP or MNI as the unit of analysis: *Balistidae* spp., *Diodontidae* spp. and *Monacanthidae* spp. Due to the small amount of material in the identified assemblage, no highly dominant taxa can be identified with confidence.

Period 2, Period 3, Period 4

No excavation units from Pahinahina dated to these temporal periods.

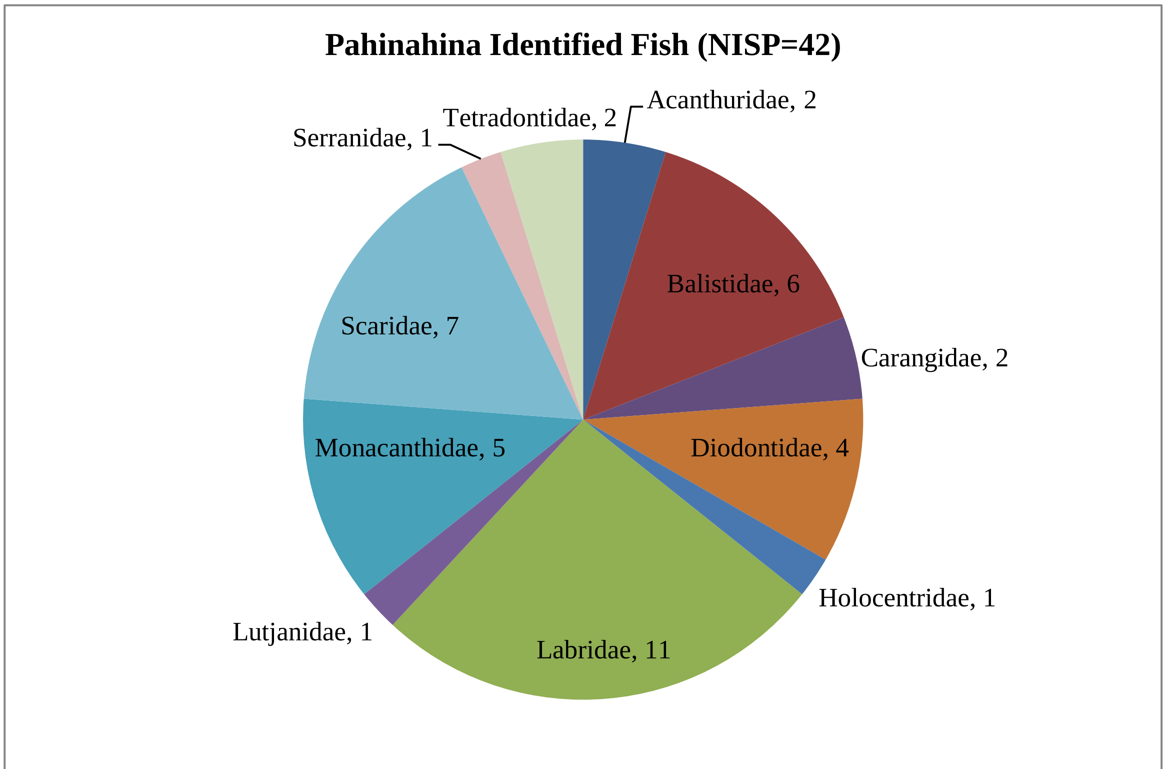


Figure 4.14a. NISP of identified fish from Pahinahina, period 1.

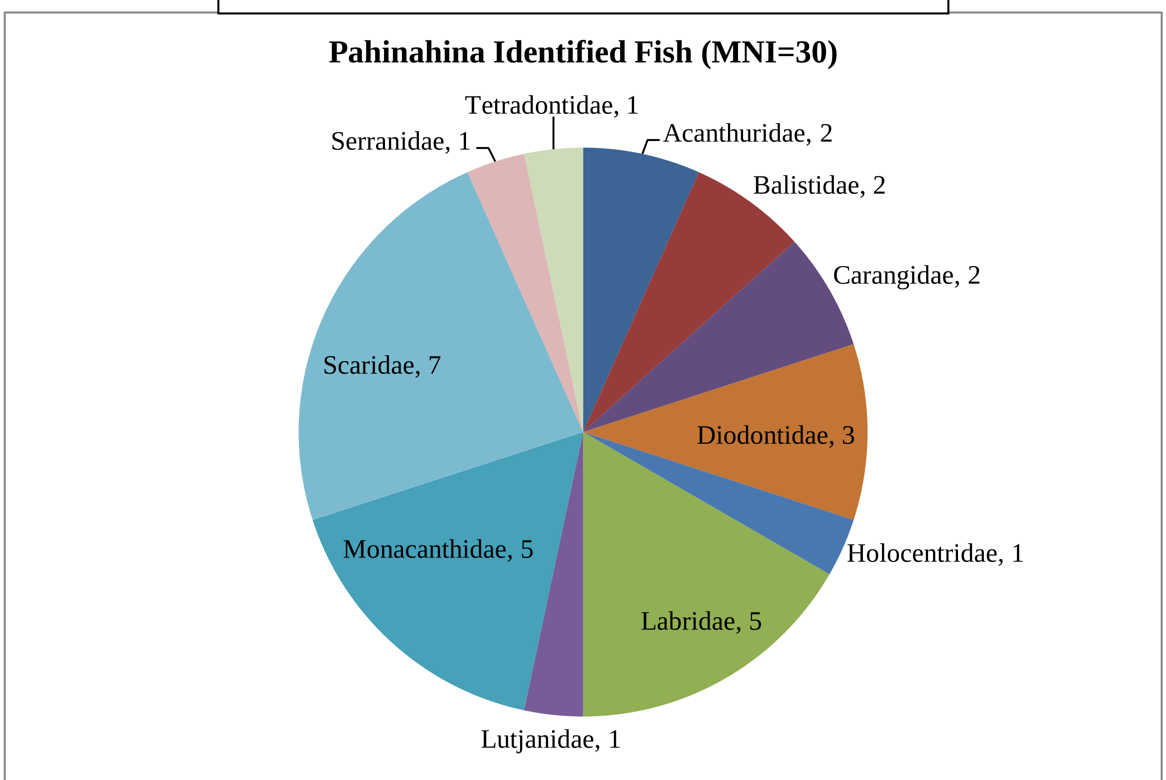


Figure 4.14b. MNI of identified fish from Pahinahina, period 1.

Part 2: Taxonomic Ranking

The sample size of this ichthyofaunal assemblage is too small to allow a robust analysis of prehistoric fishing strategies. The number of identified fish is low, and is spread amongst a much larger number of excavation units. This makes statistical analysis for trends over time very dependent on sample size (Grayson 1984). An alternative measure is to use taxonomic ranking, an ordinal measure of the abundance of each taxon. However, some very general trends in species exploitation over space and time can be identified and will be discussed briefly below by temporal period.

Period 1

Due to the small number of identified fish dating to the first temporal period, many taxa are proportionally equal to each other, and no taxa truly dominate the assemblage. The number of taxa exploited is slightly different between the *ahupuaʻa,* with Pahinahina having the greatest taxonomic diversity. This is not a significant difference (p=.633). However, *Scaridae* spp. and *Labridae* spp. are consistently the most common taxa identified throughout the first period. Other highly ranked taxa are commonly identified families: *Balistidae* spp., *Monacanthidae* spp. and *Diodontidae* spp. and *Carangidae* spp. (see Table 4.1). The majority of the high-ranked species are those that have robust identifiable skeletal elements; however *Acanthuridae* spp., a small reef fish that was commonly utilized, is present in this period.

	Ahupuaʻa	Pahinahina		Makiloa		Makeanehu	
	Temporal Period	1		1		1	
Taxon (Family)	Common Name	NISP RANK	MNI RANK	NISP RANK	MNI RANK	NISP RANK	MNI RANK
Acanthuridae	Surgeonfishes	6*	4*	-	-	-	-
Balistidae	Triggerfishes	3	4*	-	-	1*	1*
Belonidae	Needlefishes	-	-	-	-	-	-
Carangidae	Jacks	6*	4*	-	-	-	-
Coryphaenidae	Dolphinfishes	-	-	-	-	-	-
Diodontidae	Porcupinefishes	5	3	-	-	-	-
Holocentridae	Soldierfishes	7*	5*	-	-	-	-
Kyphosidae	Chubs	-	-	-	-	-	-
Labridae	Wrasses	1	2*	1*	1*	1*	1*
Lutjanidae	Snappers	-	5*	-	-	-	-
Monacanthidae	Filefishes	4	2*	-	-	-	-
Mullidae	Goatfishes	-	-	-	-	-	-
Muraenidae	Eels	-	-	-	-	-	-
Ostraciidae	Boxfishes	-	-	-	-	-	-
Pomacentridae	Damselfishes	-	-	-	-	-	-
Priacanthidae	Bigeyes	-	-	-	-	-	-
Scaridae	Parrotfishes	2	1	1*	1*	-	-
Scombridae	Tunas	-	-	-	-	-	-
Scorphaenidae	Scorpionfishes	-	-	-	-	-	-
Serranidae	Groupers	7*	5*	-	-	-	-
Tetradontidae	Pufferfishes	6*	5*	-	-	-	-

Table 4.1. Period 1 rankings.

Period 2

There was also a small number of identified fish dating to the second temporal period. Again, many taxa are proportionally equal to each other and no taxa truly dominate the assemblage (Table 4.2). Once again, *Scaridae* spp. and *Labridae* spp. are commonly highly ranked throughout this period. Similar taxa to Period 1 are also highly ranked: *Balistidae* spp., *Monacanthidae* spp., *Diodontidae* spp. and *Carangidae* spp. Of note is the inclusion of *Belonidae* spp., which is present only in the Makiloa assemblage. These fish are known to have been commonly consumed in prehistory but are not commonly found in archaeological deposits due to the extremely fragile nature of their identifiable skeletal elements (Kirch 1985).

	Ahupua‘a	Makiloa		Makeanehu		Kālala		Kaiholena	
	Temporal Period	2		2		2		2	
Taxon (Family)	Common Name	RANK	RANK	RANK	RANK	RANK	MNI RANK	RANK	RANK
Acanthuridae	Surgeonfishes	-	-	-	-	-	-	-	-
Balistidae	Triggerfishes	2	2	2*	3*	1*	1*	1*	1*
Belonidae	Needlefishes	5	5	-	-	-	-	-	-
Carangidae	Jacks	-	-	4	4	-	-	-	-
Coryphaenidae	Dolphinfishes	-	-	-	-	-	-	-	-
Diodontidae	Porcupinefishes	-	-	3	3*	-	-	1*	1*
Holocentridae	Soldierfishes	-	-	-	-	-	-	-	-
Kyphosidae	Chubs	-	-	-	-	-	-	-	-
Labridae	Wrasses	3	3	2*	3*	1*	1*	-	-
Lutjanidae	Snappers	-	-	-	-	-	-	-	-
Monacanthidae	Filefishes	4	4	1*	1	-	-	-	-
Mullidae	Goatfishes	-	-	-	-	-	-	-	-
Muraenidae	Eels	-	-	-	-	-	-	-	-
Ostraciidae	Boxfishes	-	-	-	-	-	-	-	-
Pomacentridae	Damselfishes	-	-	-	-	-	-	-	-
Priacanthidae	Bigeyes	-	-	-	-	-	-	-	-
Scaridae	Parrotfishes	1	1	1*	2	1*	1*	-	-
Scombridae	Tunas	-	-	-	-	-	-	-	-
Scorphaenidae	Scorpionfishes	-	-	-	-	-	-	-	-
Serranidae	Groupers	-	-	-	-	-	-	-	-
Tetradontidae	Pufferfishes	-	-	-	-	-	-	-	-

Table 4.2. Period 2 rankings.

Period 3

This period had the greatest number of identified fish. The patterns seen in these rankings can provide better insight into fish utilization during this time. A large number of taxa are exploited throughout this period in each assemblage (more than 5 for each *ahupua'a*). *Scaridae* spp. and *Labridae* spp. are highly ranked again, as well as *Balistidae* spp., *Monacanthidae* spp., *Diodontidae* spp. and *Carangidae* spp. (Table 4.3). *Acanthuridae* spp. is also in the top five ranking for Makiloa. This is the only period where *Pomacentridae* spp. and *Priacanthidae* spp. are identified (in Makiloa); this may be due to the greater number of excavation units and fish remains recovered during this period than preceding ones.

	Ahupua‘a	Makiloa		Makeanehu		Kaiholena		Kālala	
	Temporal Period	3		3		3		3	
Taxon (Family)	Common Name	RANK	RANK	RANK	RANK	RANK	MNI RANK	RANK	RANK
Acanthuridae	Surgeonfishes	5*	5*	-	-	-	-	-	-
Balistidae	Triggerfishes	2*	2	3*	3*	2*	2*	5*	5*
Belonidae	Needlefishes	8*	7*	-	-	-	-	-	-
Carangidae	Jacks	4	5	3*	3*	2*	2*	5*	4*
Coryphaenidae	Dolphinfishes	7*	6*	-	-	-	-	6*	5*
Diodontidae	Porcupinefishes	5*	5*	-	-	2*	2*	1	1*
Holocentridae	Soldierfishes	-	-	-	-	-	-	-	-
Kyphosidae	Chubs	-	-	-	-	-	-	-	-
Labridae	Wrasses	2*	3	-	-	2*	2*	2	2
Lutjanidae	Snappers	8*	7*	-	-	-	-	4*	4*
Monacanthidae	Filefishes	3	4	1	1	-	-	6*	5*
Mullidae	Goatfishes	6	5*	-	-	-	-	-	-
Muraenidae	Eels	-	-	-	-	-	-	-	-
Ostraciidae	Boxfishes	-	-	-	-	2*	2*	-	-
Pomacentridae	Damselfishes	8*	7*	-	-	-	-	-	-
Priacanthidae	Bigeyes	8*	7*	-	-	-	-	-	-
Scaridae	Parrotfishes	1	1	2	2	1	1	3	1*
Scombridae	Tunas	7*	6*	-	-	-	-	-	-
Scorphaenidae	Scorpionfishes	-	-	-	-	-	-	6*	5*
Serranidae	Groupers	-	-	-	-	-	-	-	-
Tetradontidae	Pufferfishes	8*	7*	-	-	-	-	4*	3

Table 4.3. Period 3 rankings.

Period 4

Excavation units dating to Period 4 were only in Kālala. Overall, the taxonomic ranking is similar to earlier patterns, which *Scaridae* spp. and *Labridae* spp. ranked first and second, respectively (Table 4.4). This period does differ in that *Lutjanidae* spp. is more common in this assemblage than previously. However, this data set was small, and these ranking values may not accurately reflect patterns of fish utilization during this period.

	Ahupua‘a	Kālala	
	Temporal Period	4	
Taxon (Family)	Common Name	NISP RANK	MNI RANK
Acanthuridae	Surgeonfishes	-	-
Balistidae	Triggerfishes	5*	5*
Belonidae	Needlefishes	-	-
Carangidae	Jacks	5*	5*
Coryphaenidae	Dolphinfishes	-	-
Diodontidae	Porcupinefishes	5*	5*
Holocentridae	Soldierfishes	-	-
Kyphosidae	Chubs	-	-
Labridae	Wrasses	2	2
Lutjanidae	Snappers	4	4
Monacanthidae	Filefishes	3	3
Mullidae	Goatfishes	-	-
Muraenidae	Eels	5*	5*
Ostraciidae	Boxfishes	-	-
Pomacentridae	Damselfishes	-	-
Priacanthidae	Bigeyes	-	-
Scaridae	Parrotfishes	1	1
Scombridae	Tunas	-	-
Scorphaenidae	Scorpionfishes	-	-
Serranidae	Groupers	-	-
Tetradontidae	Pufferfishes	5*	5*

Table 4.4. Period 4 rankings.

Part 3: Analyses of Faunal Assemblage for Evidence of Resource Depression

As stated in chapter 3, unequivocal evidence for resource depression in the archaeological record is defined by the following conditions:

1. Prey Index values must decrease significantly through time.
2. Evenness values for identified fish must increase significantly through time.
3. The number of identified species (NTAXA) must increase significantly through time.
4. The average size of fish must decrease significantly through time.

The values used in the prey index were from the complete Kohalan ichthyofaunal assemblage, since there were not enough identified remains to conduct the test within each *ahupuaʻa* for all 4 periods. The tests on evenness and NTAXA were analyzed for each *ahupuaʻa*, since these tests used the complete identified assemblage, instead of only two taxa. An evenness value and NTAXA for each test unit was found, and the ANOVA analysis to test for change through time was conducted on the data from each temporal period within an *ahupuaʻa*. Like the prey index, the tests for changes in the average size of fish were conducted on the complete Kohalan ichthyofaunal assemblage.

I also examine broad changes in the faunal assemblage for all of Kohala, and conducted tests for significant changes in NTAXA and evenness for the complete Kohalan assemblage to gain a better understanding of the general trends in all *ahupuaʻa* through time. To examine potential differences in fish consumption within Kohala, the assemblages of coastal and upland sites are compared. Fishing strategies are examined by comparing the different ocean biotic zones that were exploited, by proxy of using life histories of the identified taxa.

Prey Index

The most common high-ranked taxon in this assemblage was *Scaridae* spp. and the most common low-ranked taxon was *Labridae* spp. These were the two taxa which were utilized for a prey index examination. The results of the prey index show an increase in the index value from Period 1 to Period 2, but then a slight decrease from Period 2 to Period 4 (see Figure 4.15). This decrease reflects a greater amount of *Labridae* spp. in the assemblage from Period 2 to Period 4. However, when put to a Chi-square test, these values are not significantly different than the null hypothesis ($H_{0:}$ Index value $\neq 0.50$; $p>0.70$) and do not change significantly ($p>0.95$).

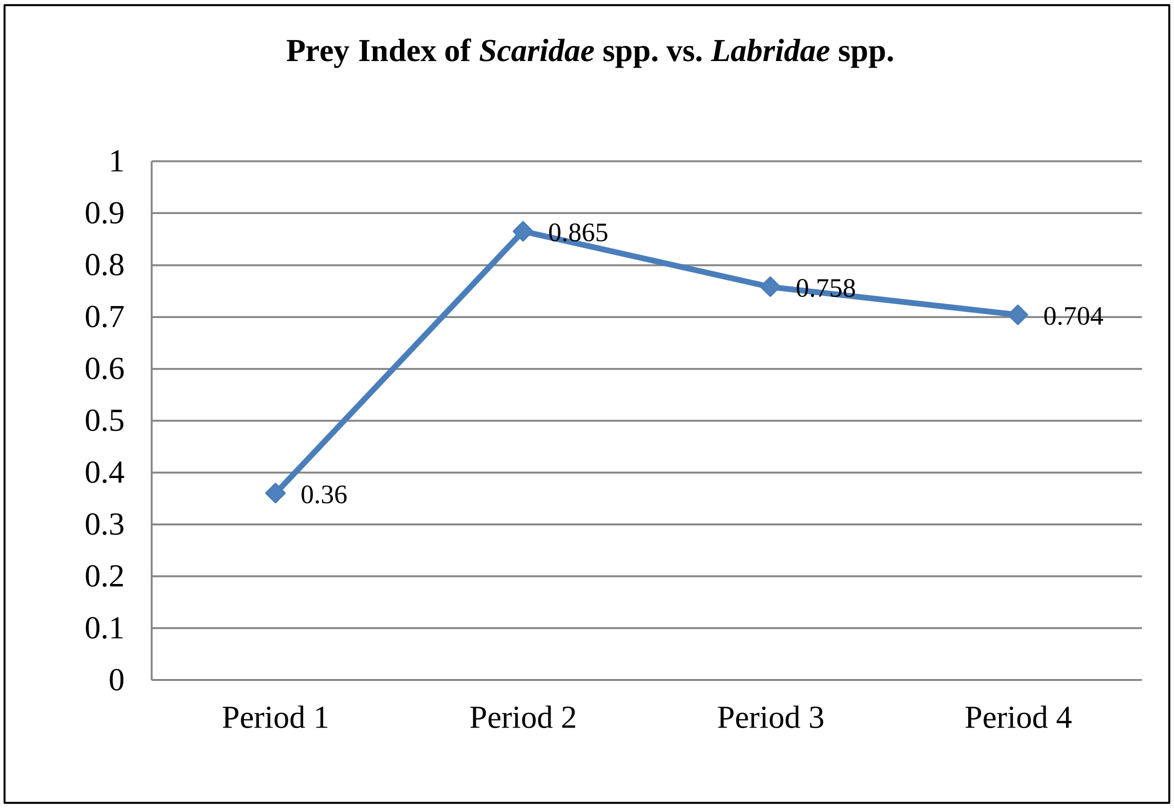


Figure 4.15. Prey index values of *Scaridae* spp. vs. *Labridae* spp..

Evenness and NTAXA of Identified Ichthyofaunal Assemblage

Kaiholena

Only 4 of the excavation units in Kaiholena contained identifiable fish, and the NISP of identified fish was very small (n=11). This data set is too small and statistical analysis of it is not very robust. The range of evenness values was 0.04 (on a scale of 0.0-1.0) and the range of NTAXA was 3 (Figure 4.16). The evenness values do not change significantly through time ($p=.667$). NTAXA appears to increase through time; however this change is not significant ($p=.868$). No evidence for resource depression is seen in the identified assemblage of Kaiholena.

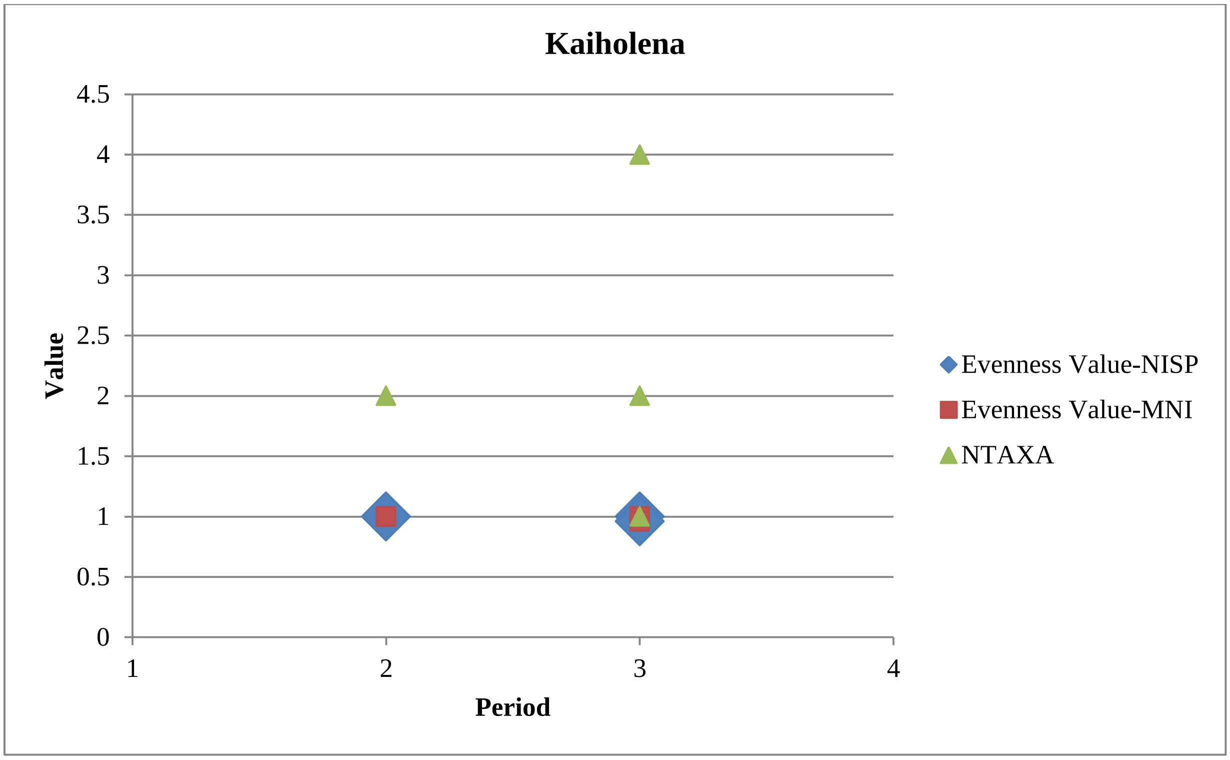


Figure 4.16. The evenness and NTAXA of the Kaiholena ichthyofaunal assemblage.

Kālala

The evenness values and NTAXA for Kālala show much variation through time; the range of evenness values was 0.41 (on a scale of 0.0-1.0) and the range of NTAXA was 8 taxa (Figure 4.17). The evenness values for Kālala do not differ significantly through time ($p=.672$); however NTAXA does change significantly ($p<.05$). This analysis concludes that NTAXA in Kālala decreases through time, and does not indicate resource depression.

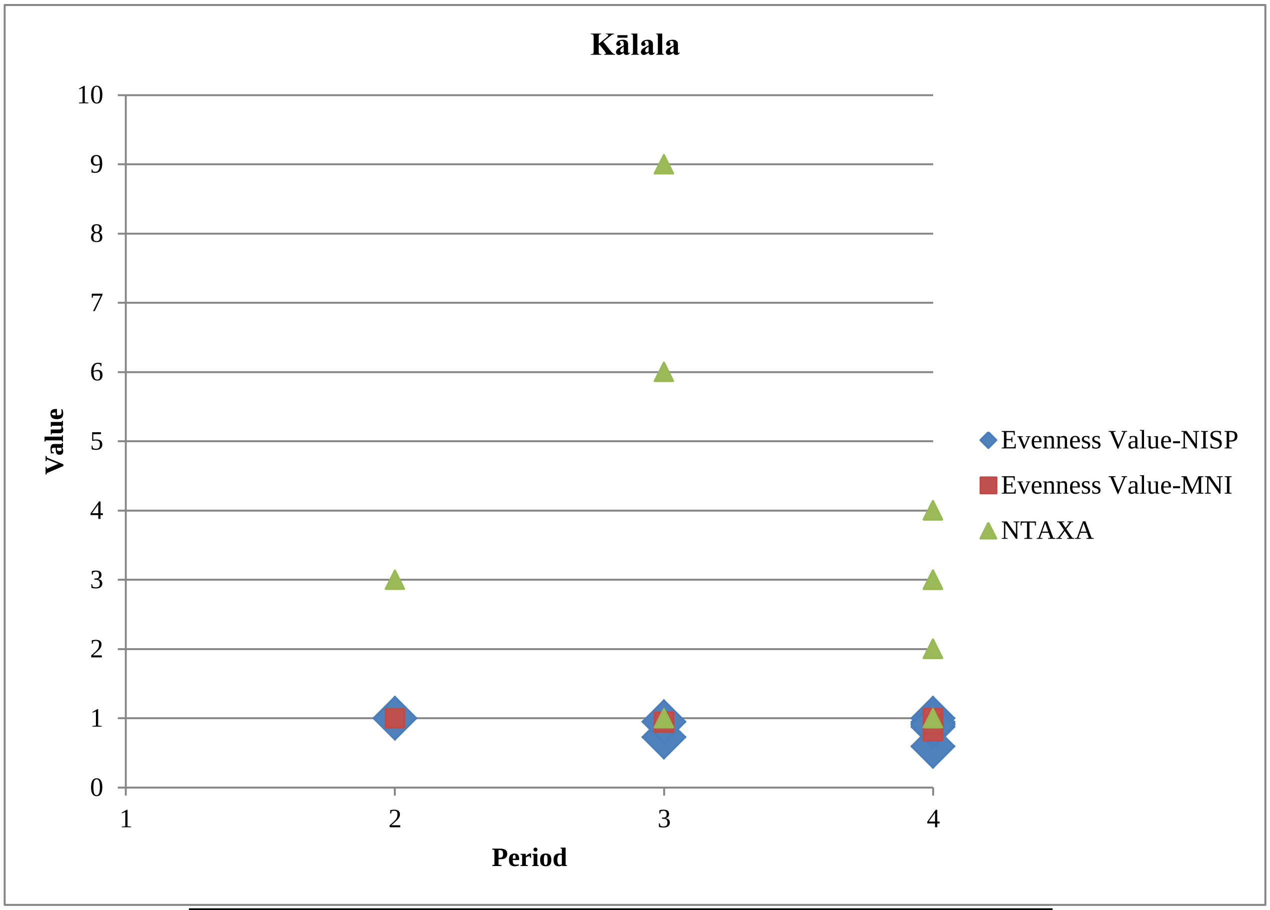


Figure 4.17. Evenness and NTAXA of the Kālala ichthyofaunal assemblage.

Makeanehu

Like Kaiholena, Makeanehu had a small number of dated excavation units that contained identifiable fish (n=6). However, it did have a larger identified assemblage (NISP=55). The range of evenness values was 0.47 and the range of NTAXA was 5. The evenness values of Makeanehu did change significantly through time ($p=.014$) and appear to decrease (Figure 4.18). The number of identified taxa did not change significantly through time ($p=.781$). The decrease in evenness values does not indicate resource depression.

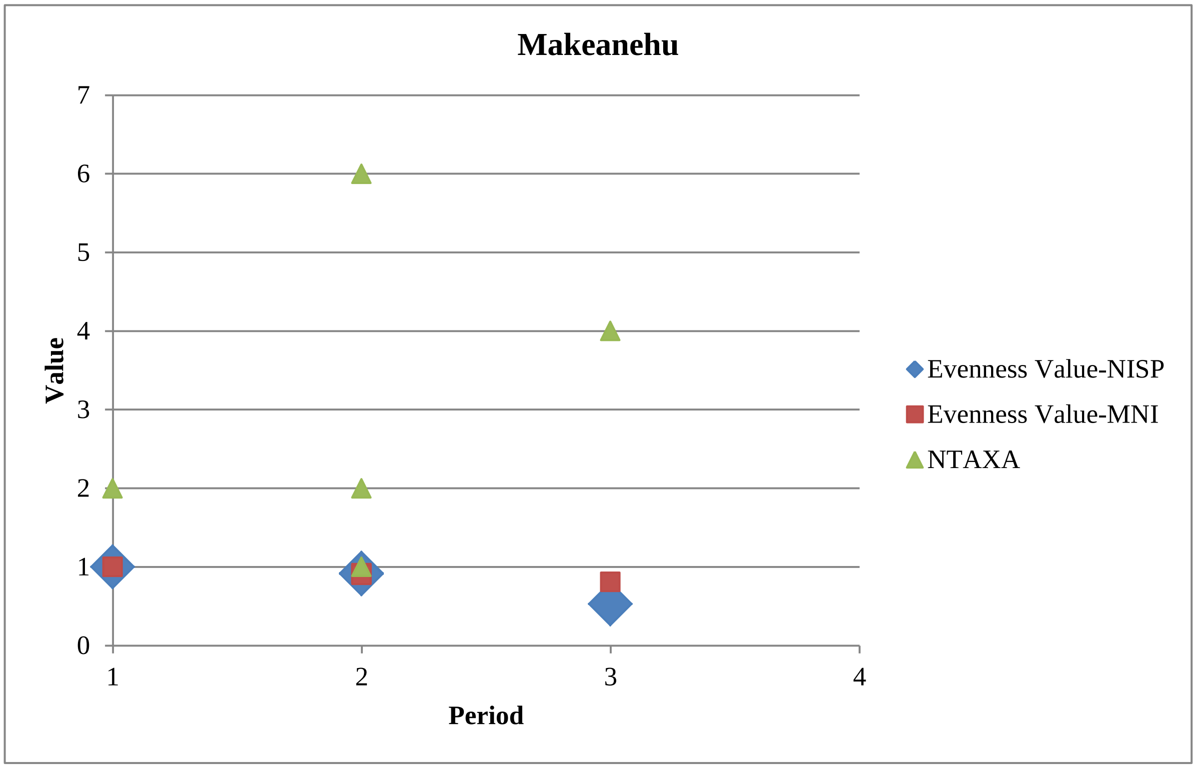


Figure 4.18. Evenness and NTAXA of the Makeanehu ichthyofaunal assemblage.

Makiloa

Makiloa had the greatest number of dated excavation units (n=19) and largest identified ichthyofaunal assemblage (NISP=163). This may be due simply to the fact that the greatest number of excavations were conducted within this *ahupua'a*. The range of evenness values in Makiloa was 0.33 and the range of NTAXA was 9 (Figure 4.19). The evenness values of Makiloa did change significantly through time ($p=0.031$) and appear to decrease. The number of identified taxa did not change significantly through time ($p=.570$). The decrease in evenness values does not indicate resource depression.

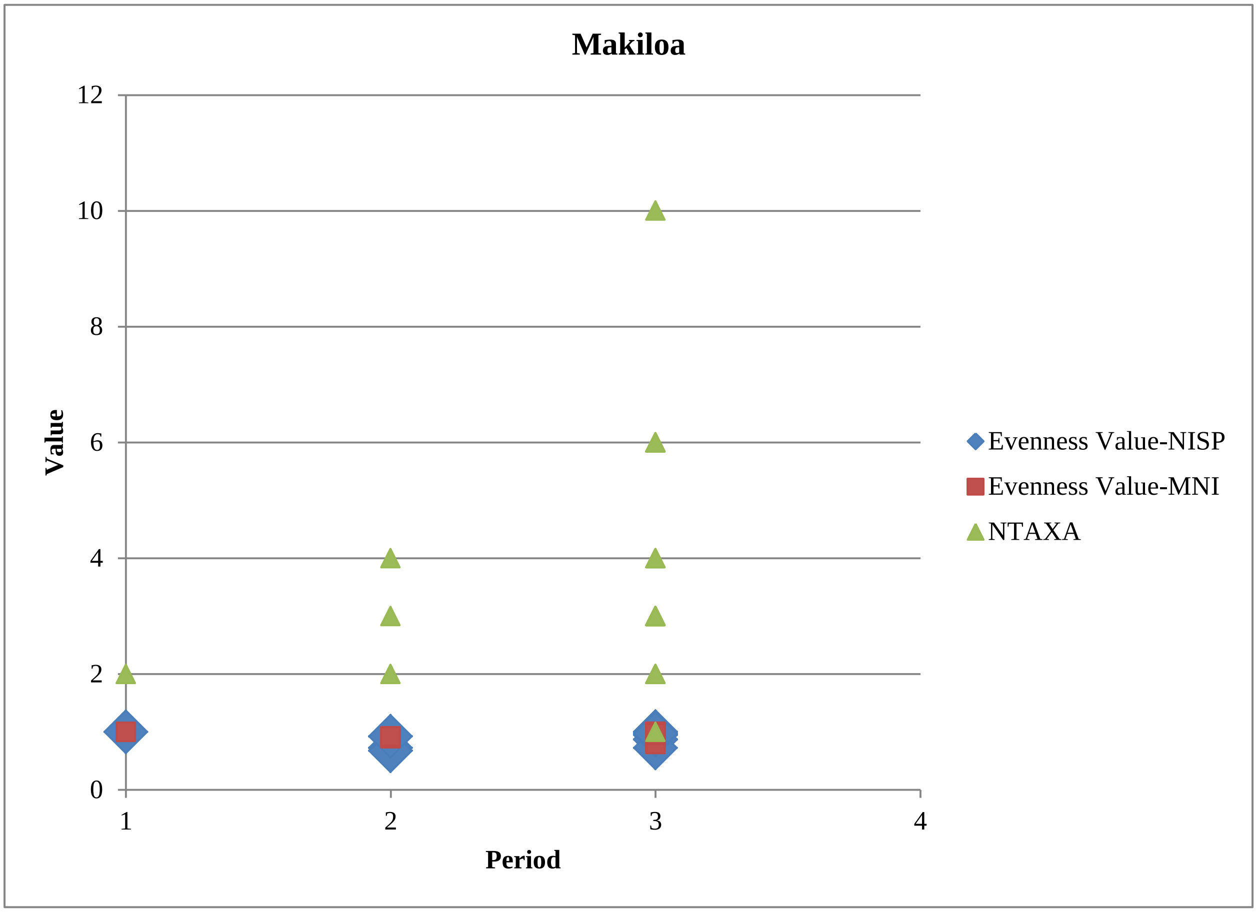


Figure 4.19. Evenness and NTAXA of the Makiloa ichthyofaunal assemblage.

Pahinahina

Since the excavation units within Pahinahina only dated to one temporal period, statistical analysis for change in the evenness of the assemblage and NTAXA could not be performed (Figure 4.20). However, the identified assemblage was included in analysis of general trends within Kohala through time (see below).

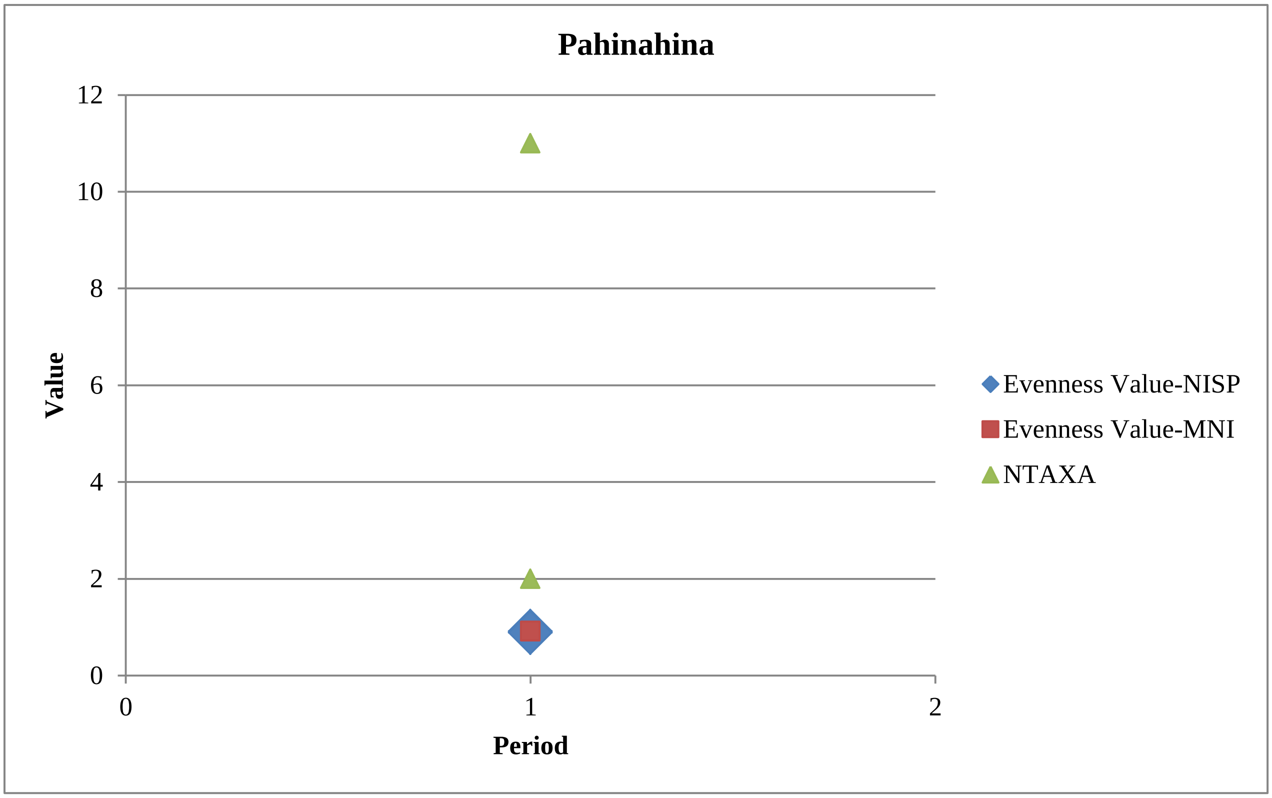


Figure 4.20. Evenness and NTAXA of the Pahinahina ichthyofaunal assemblage.

Kohala, Hawai'i

To allow for a more general analysis of the identified ichthyofaunal assemblage, I looked for significant changes through time in the average evenness and NTAXA for each *ahupua'a*, and also in the combined values for the whole of Kohala. Figure 4.21 shows the NTAXA of each excavation unit with identified fish, and Figure 4.22 shows the average NTAXA of each *ahupua'a* through time. The linear trend in Figure 4.21 was performed in Microsoft Excel, but this decrease was not significant (p=.892). The curves in Figure 4.22 are visual aids, and are in place to make it easier to identify the values for each *ahupua'a*. Figure 4.23 shows the evenness of each excavation unit, using both NISP and MNI, and Figure 4.24 shows the average evenness value of each *ahupua'a* through time. The linear trends in Figure 4.23 were performed in Excel, and these apparent decreases are not statistically significant (p=.393). The curves in Figure 4.24 are again visual aids, which do show the same general decrease in average evenness values in each *ahupua'a* (by NISP and MNI) seen in Figure 4.23. At a larger scale, these data and the results of analyses within each *ahupua'a* do not provide evidence for resource depression occurring within the Leeward Kohala area.

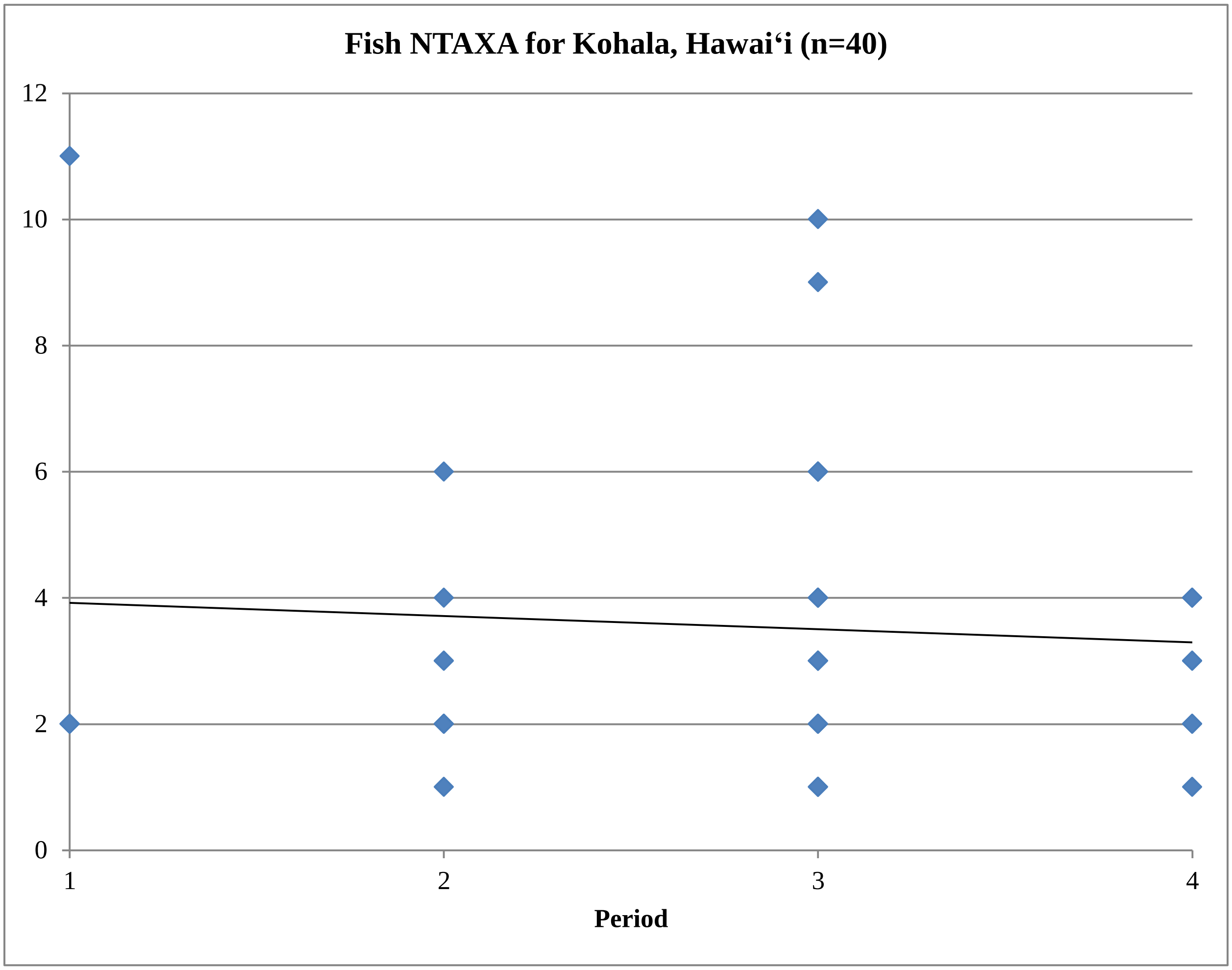


Figure 4.21. NTAXA of the combined Kohalan ichthyofaunal assemblage.

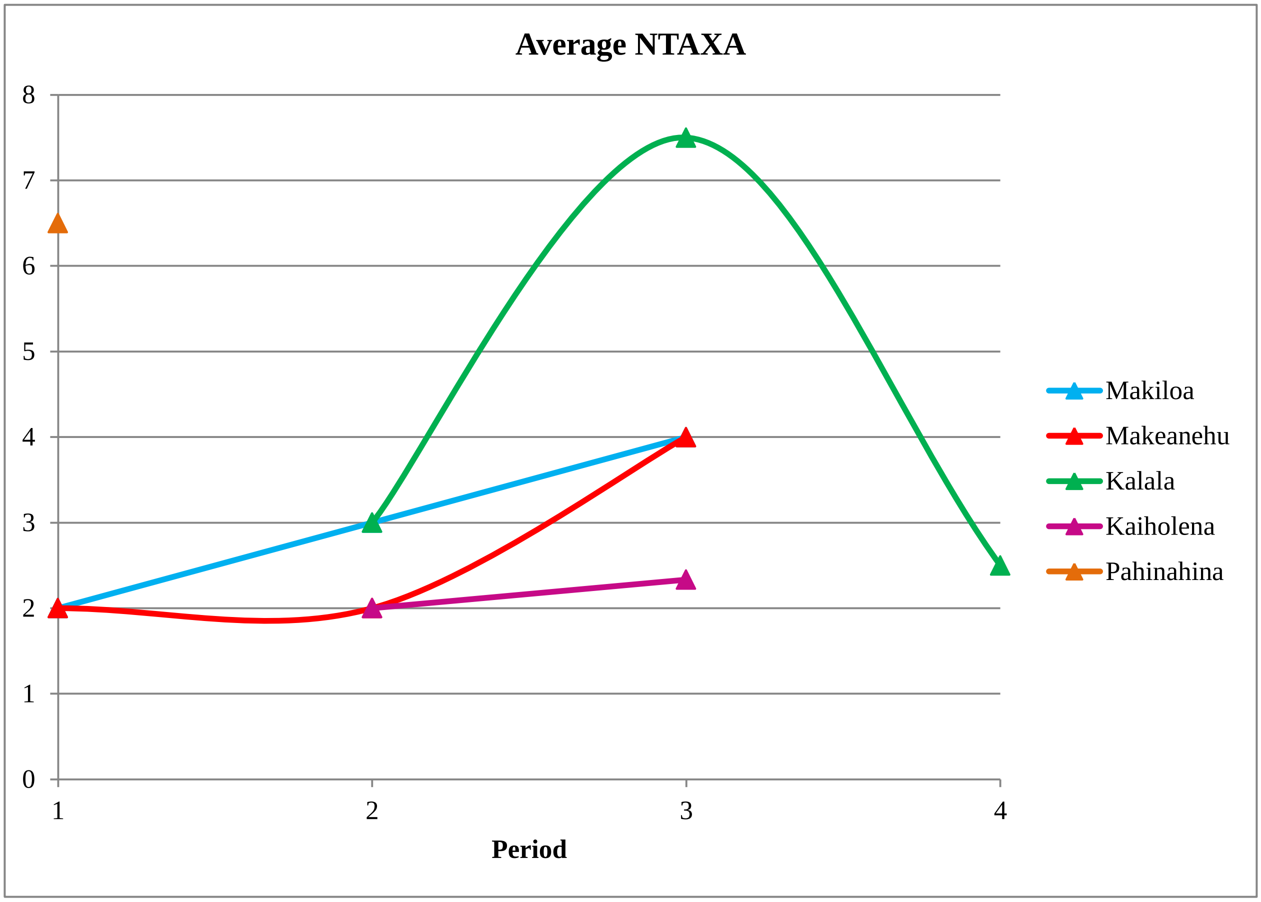


Figure 4.22. Average NTAXA of each *ahupua'a*.

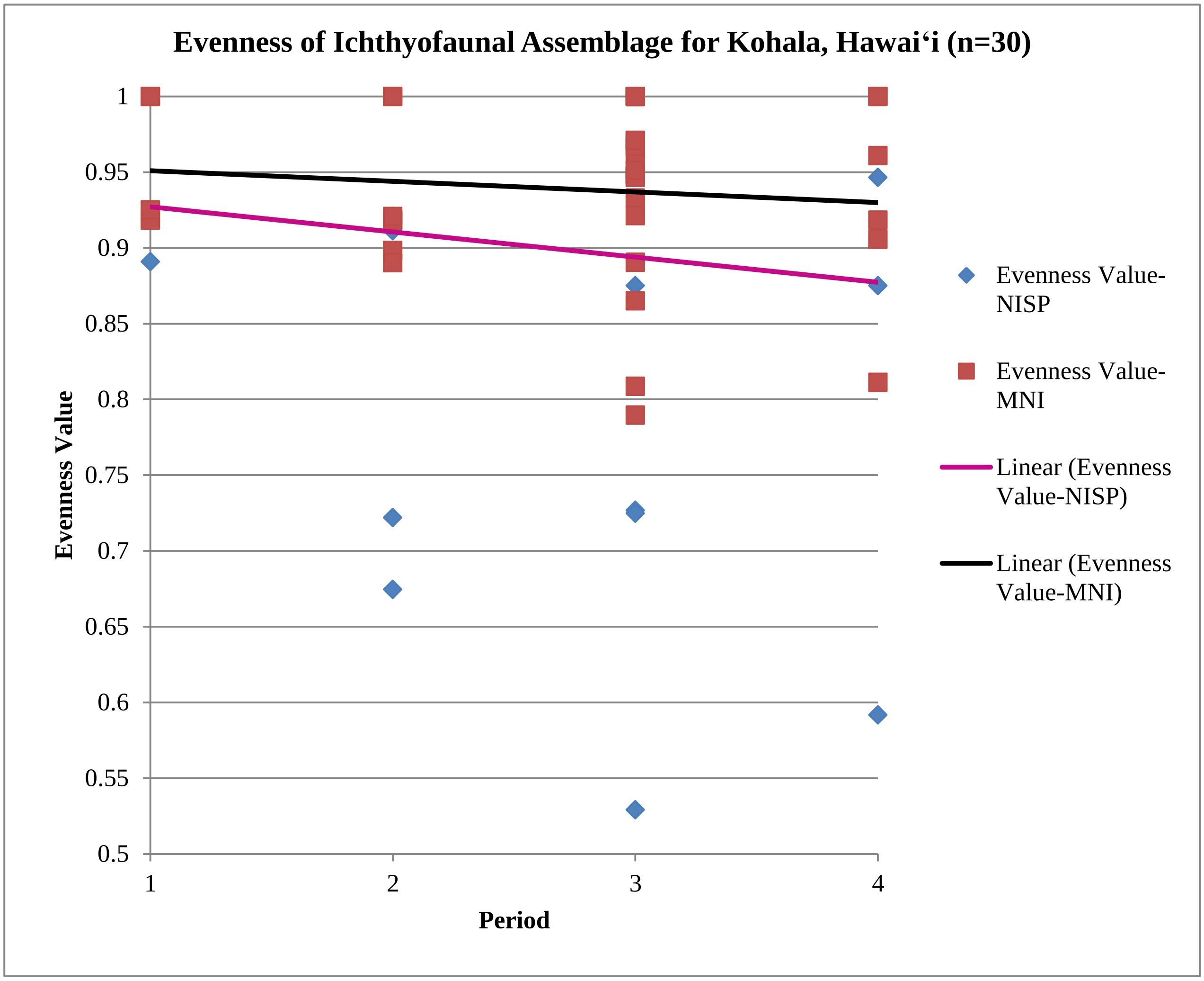


Figure 4.23. Evenness of the combined Kohalan ichthyofaunal assemblage.

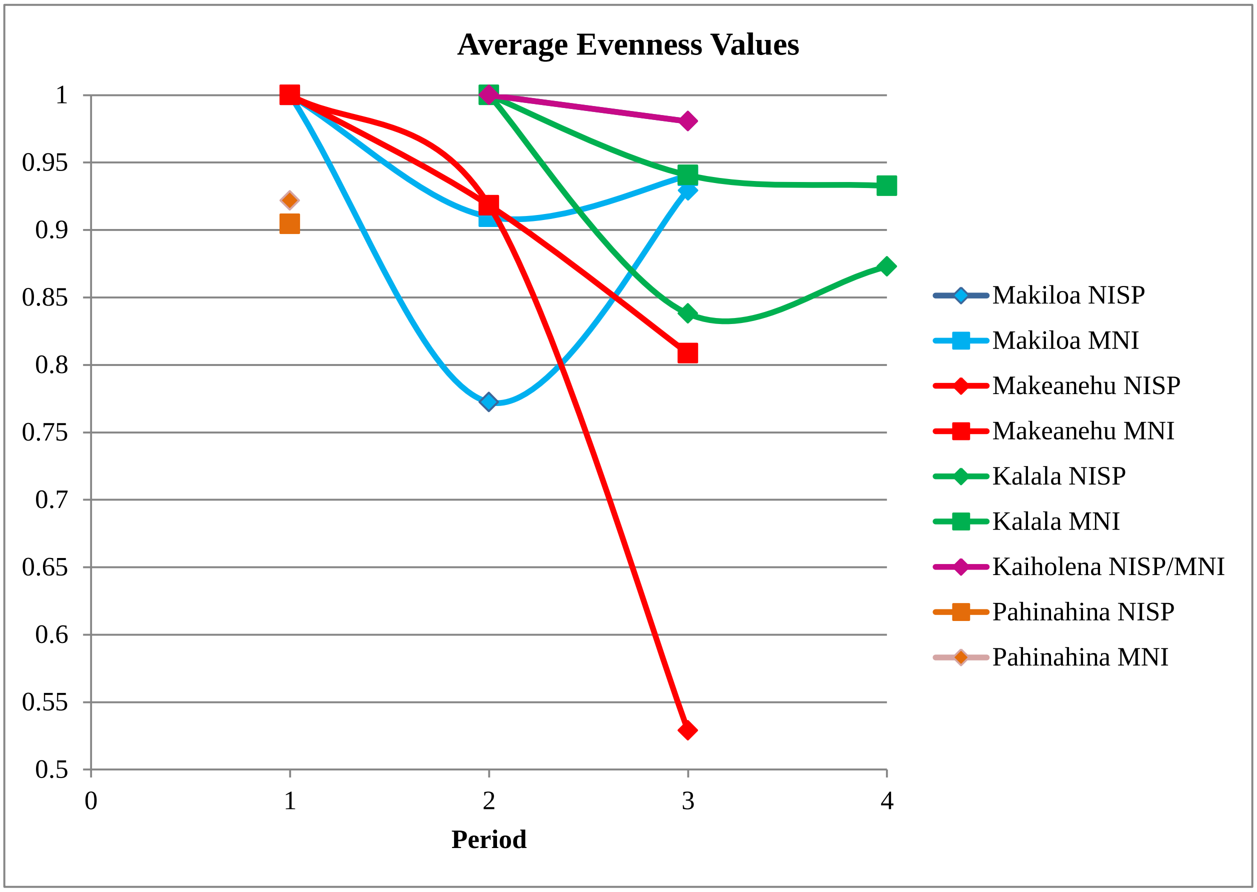


Figure 4.24. Average evenness of each *ahupuaʻa*.

Use of Different Ocean Biotic Zones

Fish species are not found homogeneously throughout the ocean; some families occupy different biotic zones (e.g., the reef, intertidal, or open ocean areas) (Kirch 1979). Different fishing strategies and technologies are used to capture different species of fish living within different biotic zones. Analyzing the identified ichthyofaunal assemblage by biotic zones provides insight into potential changes in fishing techniques through time.

The results of the analysis show that the majority of the fish in the assemblage are from the reef zone. There is not a significant change in the proportion of reef fish to pelagic/open ocean fish over time. There is an increase in the presence of pelagic fish identified through time, and this coincides possibly with the increase in amount of fish in the diet through time, or with the increase in the number of excavated sites dating to later periods (Figure 4.25; Field et al. 2008, 2009, 2010a).

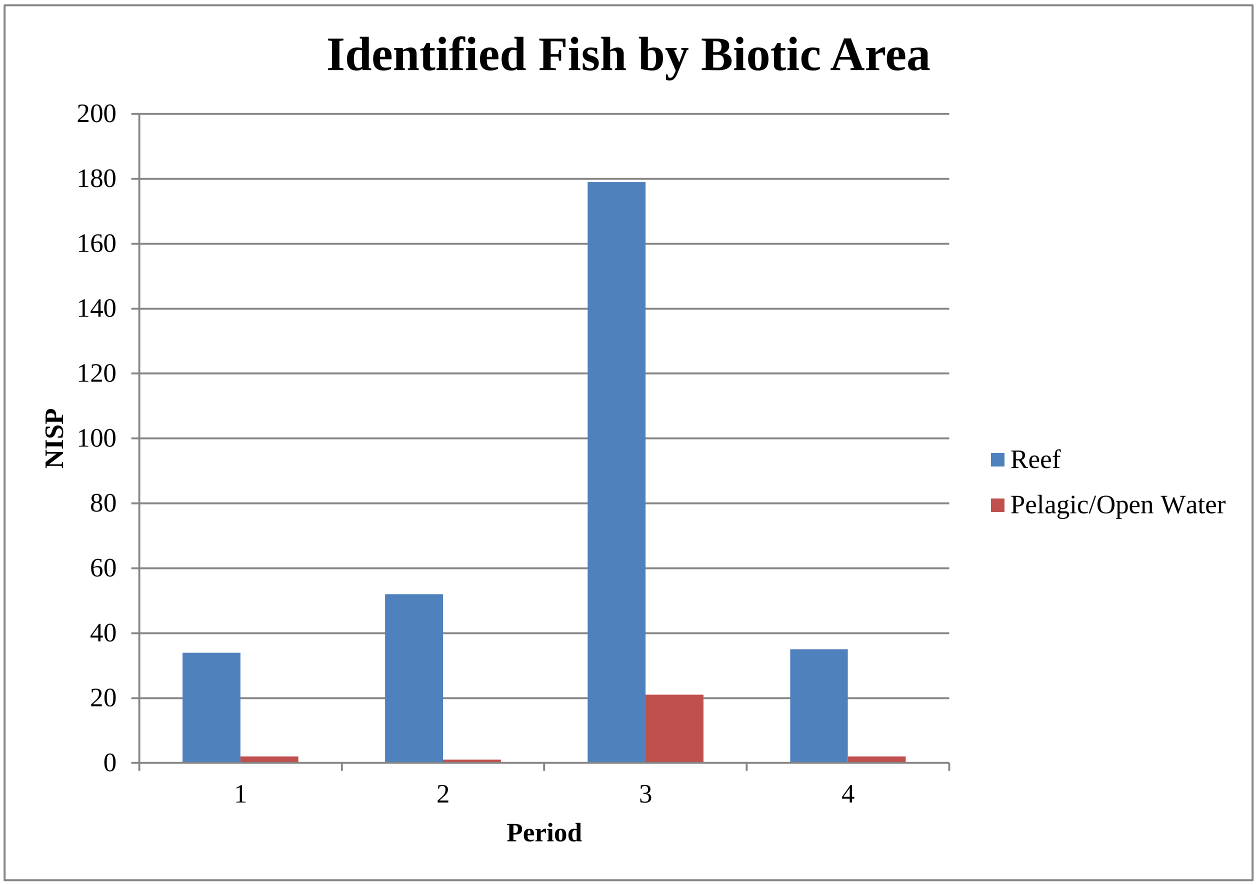


Figure 4.25. NISP of identified fish from different ocean biotic zones.

Average Size of Fish

As mentioned in the introduction, resource depression is also indicated by declines in overall fish size. Five different skeletal elements from 5 different taxa were used to test for changes in the size of fish over time. As these elements are generally robust, their preservation in the ichthyofaunal assemblage may bias the assemblage against more fragile bones. However, the taxa used were all commonly consumed in prehistory (Kirch 1985) therefore the possibility of preservation bias is not of great concern. The first dorsal spines of *Balistidae* spp. and *Monacanthidae* spp., the lower pharyngeal plates of *Scaridae* spp. and *Labridae* spp. and the upper pharyngeal plates of *Scaridae* spp. were tested for significant change in size over time. For *Scaridae* spp., it was possible to further identify the lower and upper pharyngeal plates into two different groups of genera: *Calotomus* sp. and *Scarus*/*Chlorurus* sp. These groups were tested separately.

The size of *Balistidae* spp. first dorsal spines appears to increase over time (Figure 4.26); however this change is not significant (p=.093).

The size of *Monacanthidae* spp. first dorsal spines appears to decrease slightly over time (Figure 4.27); however this change is not significant (p=.765).

The size of *Labridae* spp. lower pharyngeal plates appears to decrease slightly over time (Figure 4.28); however, this change is not significant (p=.865).

Scaridae spp.

The *Scarus/Chlorurus* sp. lower pharyngeal plates were both dated to Period 3, and therefore could not be analyzed for change over time. *Calotomus* sp. lower pharyngeals appeared to decrease slightly in size over time; however, this change is not significant (p=.276). *Scarus/Chlorurus* sp. upper pharyngeal plates appeared to increase in size over time (Figure 4.29); however, this change is also not significant (p=.189). *Calotomus* sp. upper pharyngeal plates appeared to decrease in size over time (Figure 4.30). This change is significant ($p=.046$) and the number of identified elements is the largest of the data sets tested ($n=24$). Since it is not possible to easily differentiate the species within this genera on the basis of their upper pharyngeal plates, it is unknown if this trend might be due to a difference in average size within this genera.

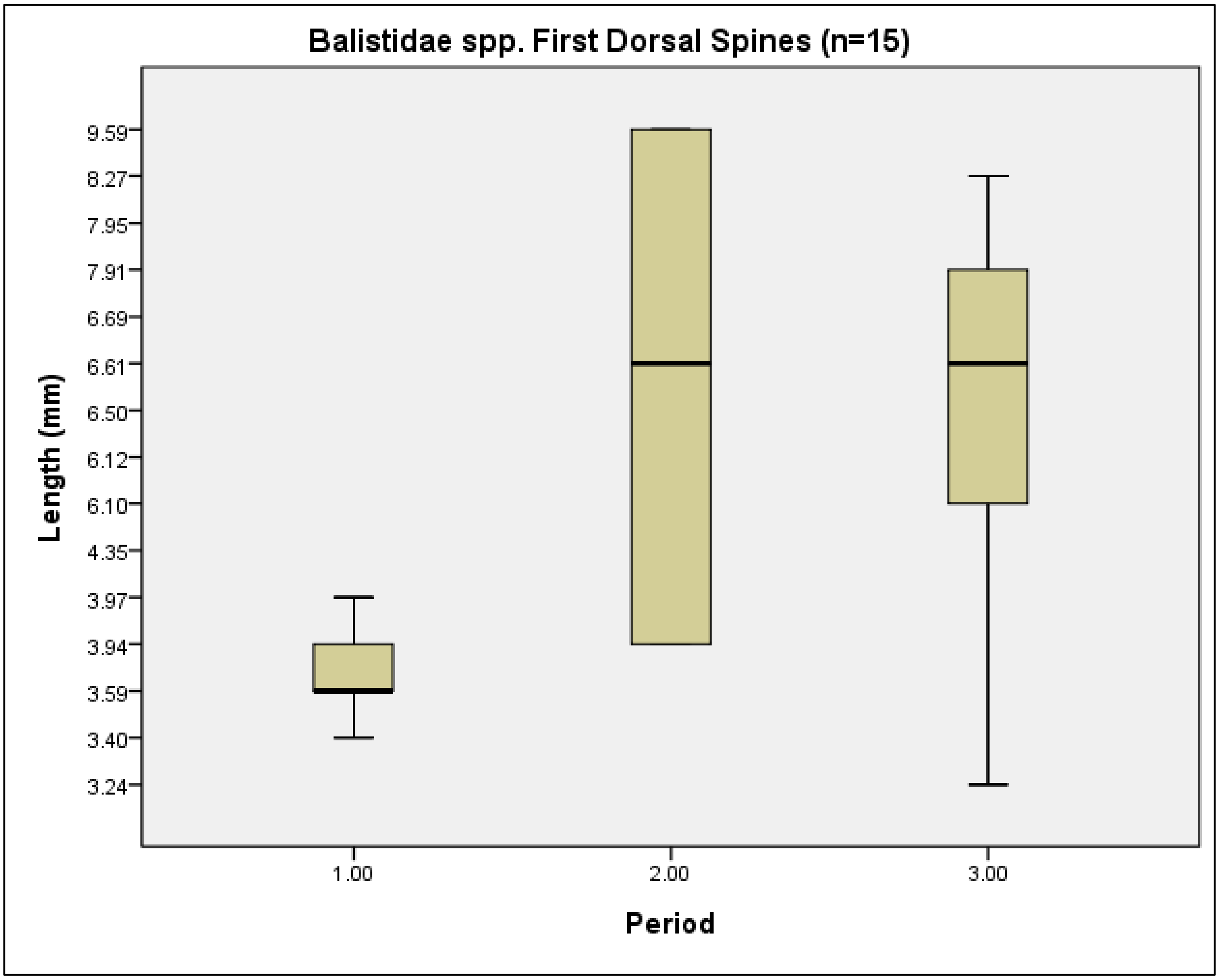


Figure 4.26. Size of *Balistidae* spp. first dorsal spines through time.

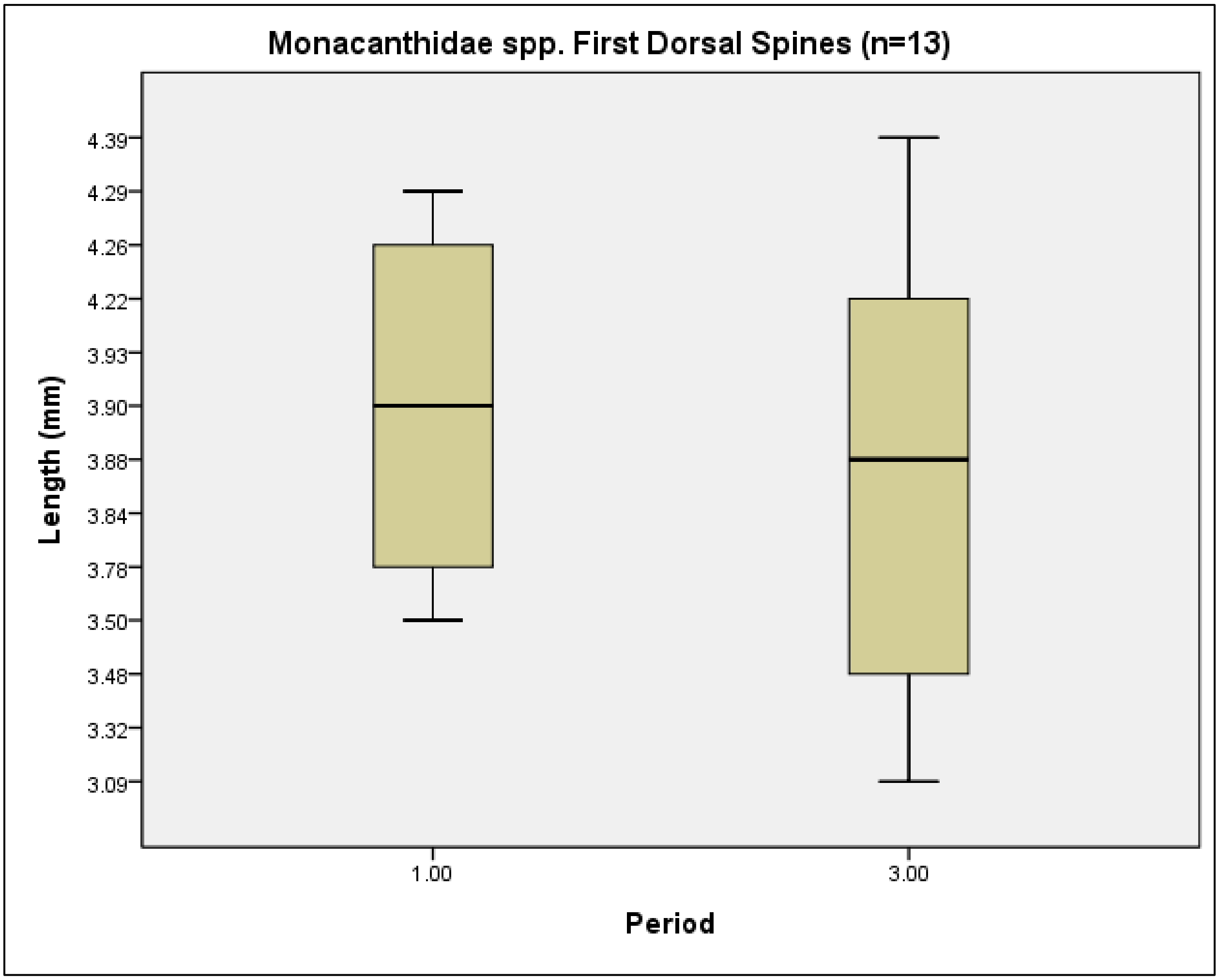


Figure 4.27. Size of *Monacanthidae* spp. first dorsal spines through time.

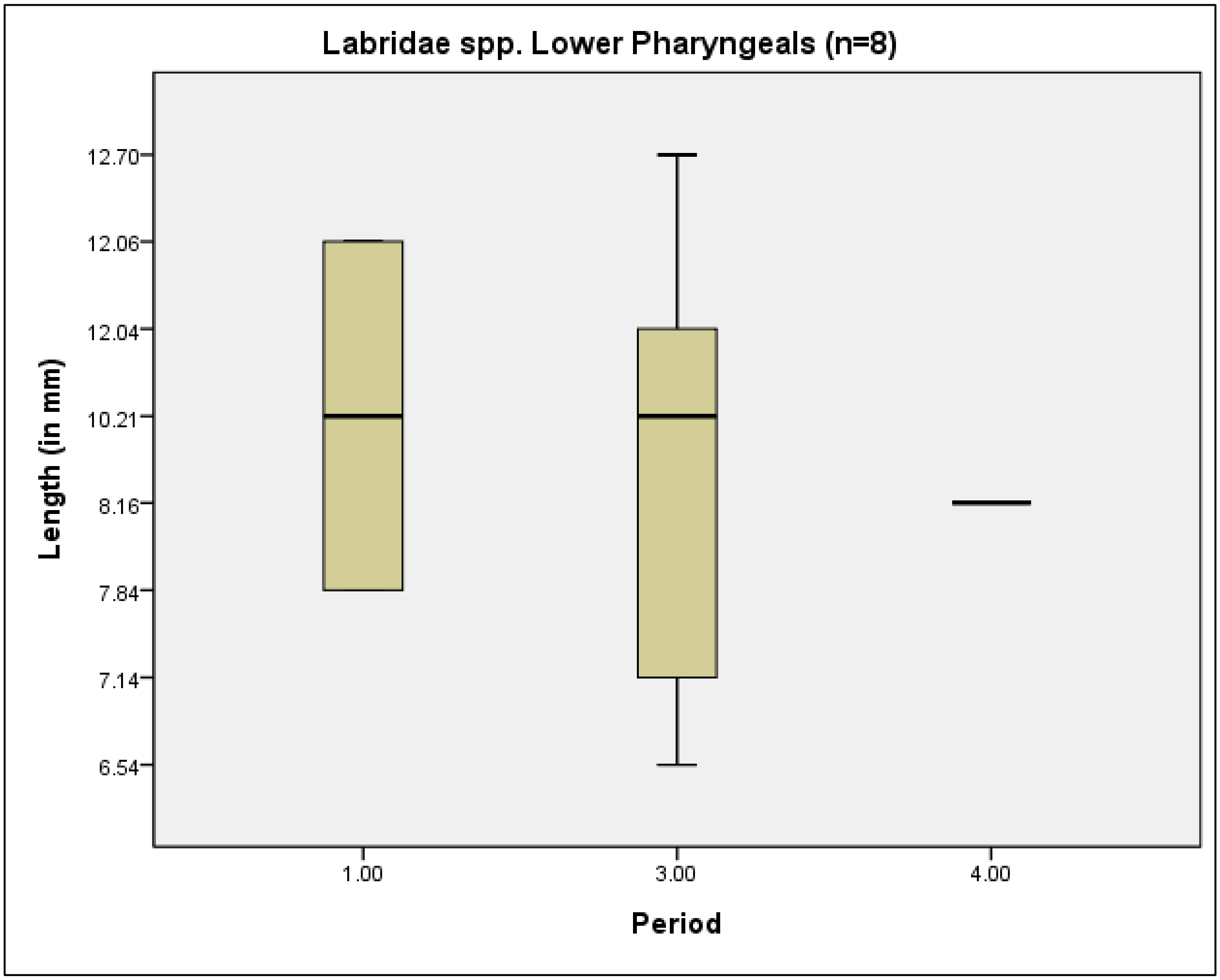


Figure 4.28. Size of *Labridae* spp. lower pharyngeal plates through time.

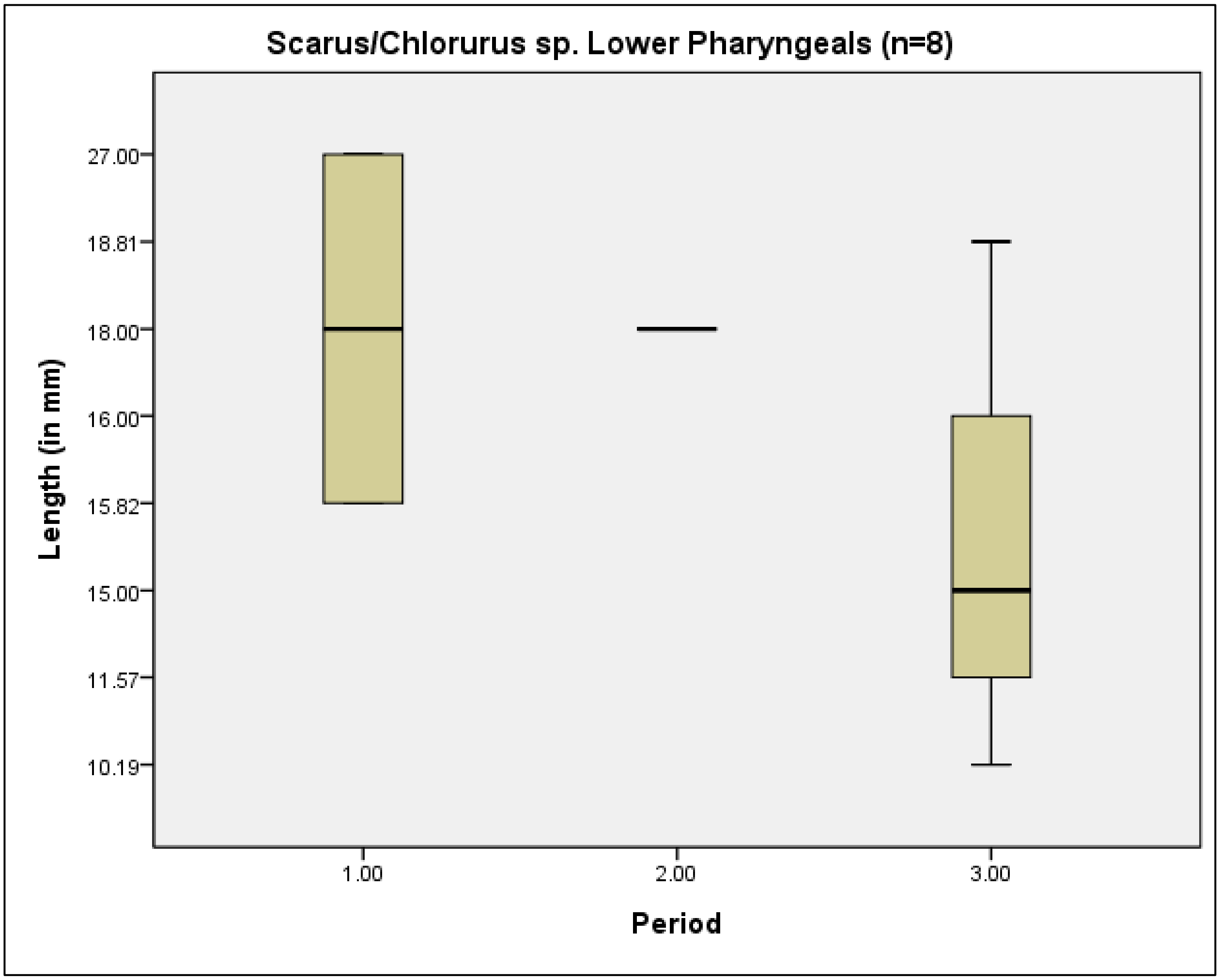


Figure 4.29. Size of *Scarus/Chlorurus* sp. lower pharyngeal plates through time.

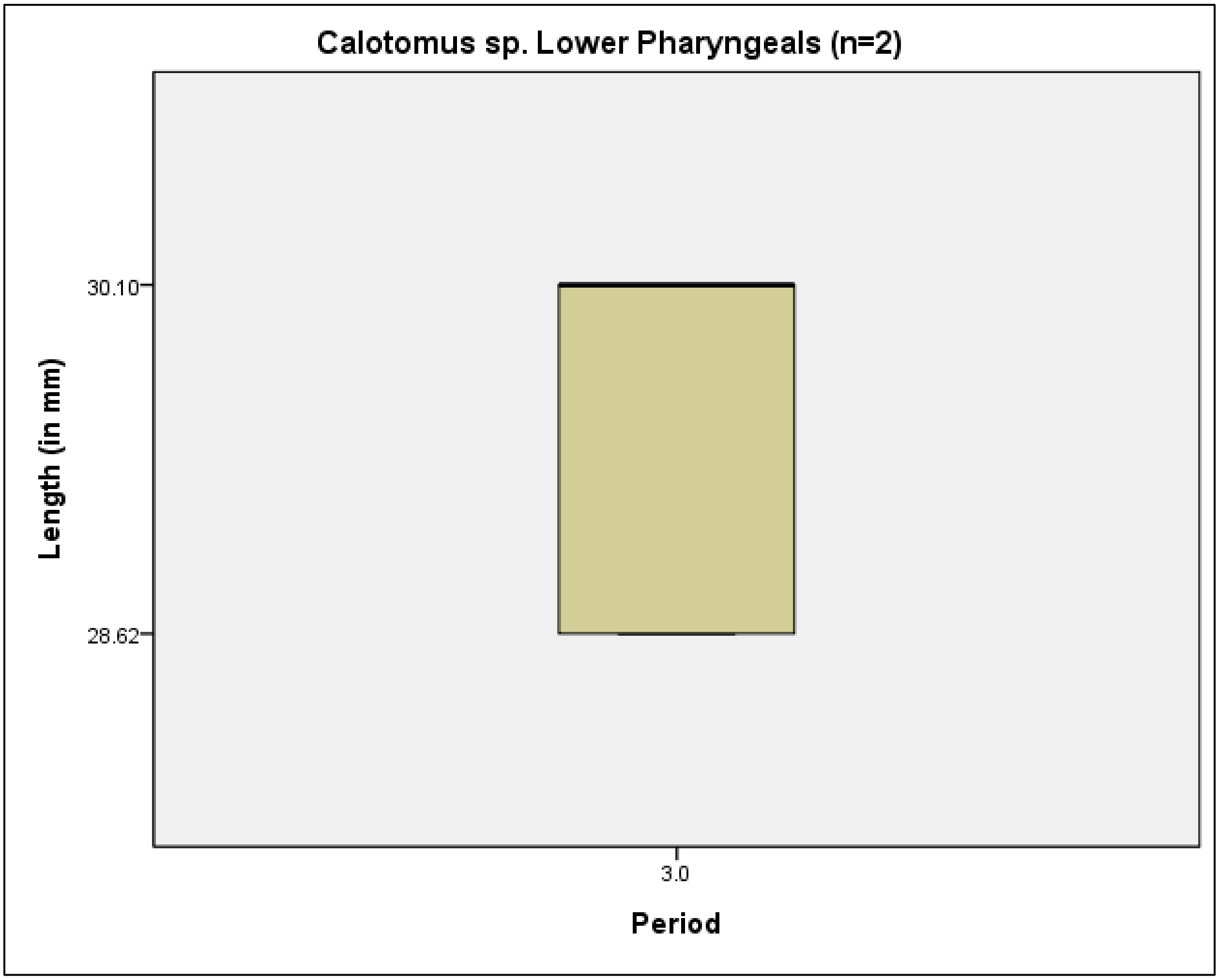


Figure 4.30. Size of *Calotomus* sp. lower pharyngeal plates through time.

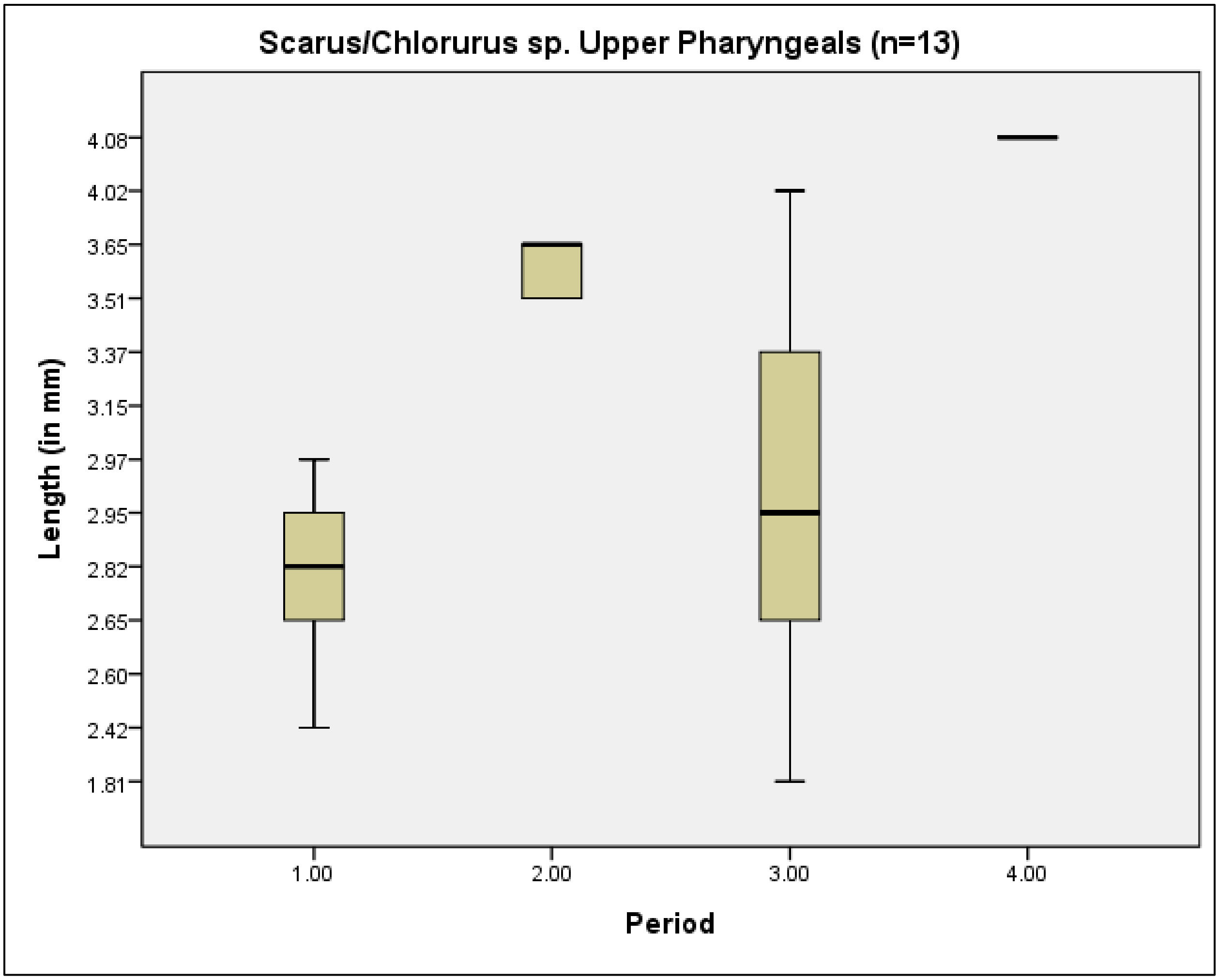


Figure 4.31. Size of *Scarus/Chlorurus* sp. upper pharyngeal plates through time.

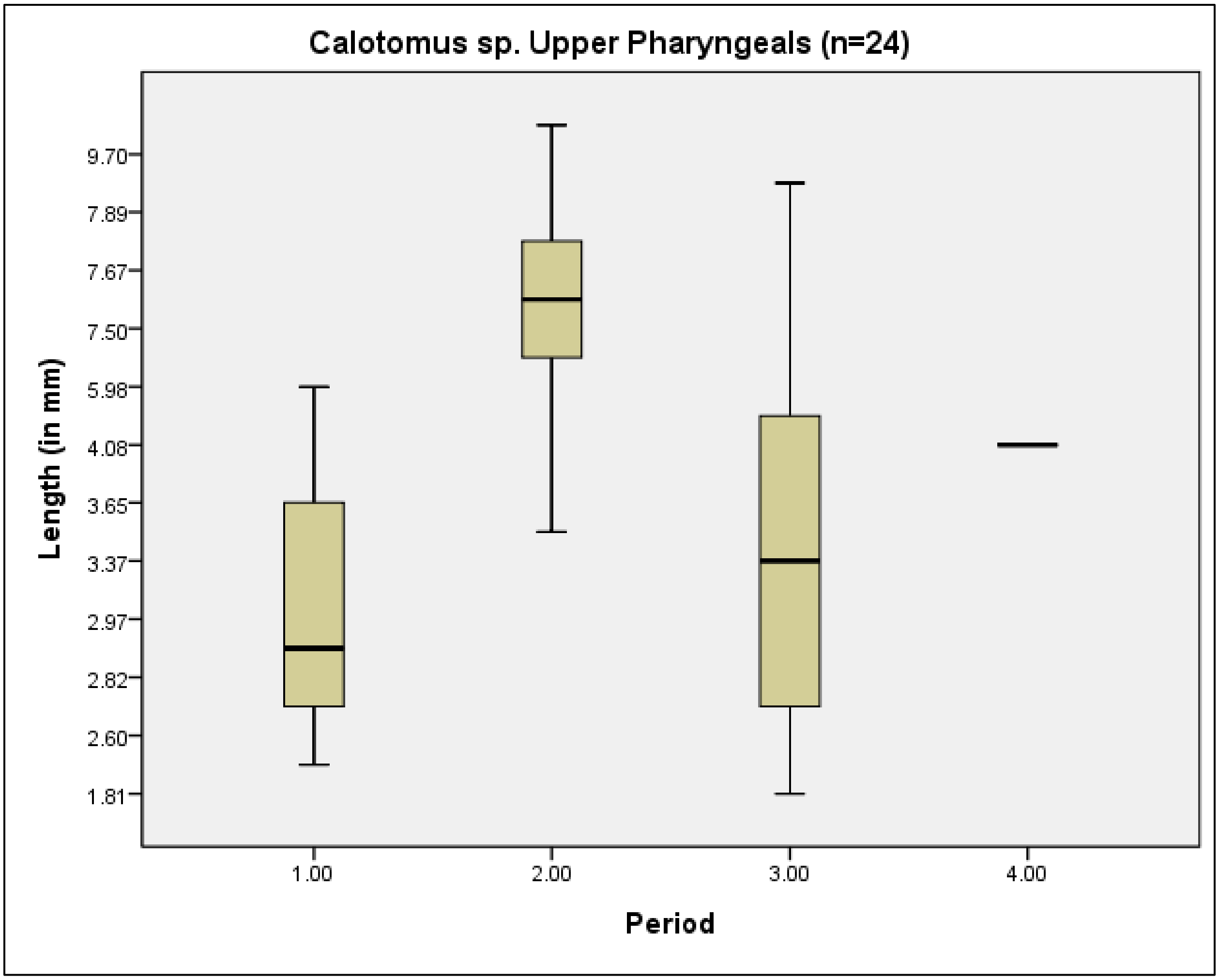


Figure 4.32. Size of *Calotomus* sp. upper pharyngeal plates through time.

Part 4: A Brief Statistical Analysis of the General Faunal Assemblage

The faunal assemblage of Kohala also includes many different species of mollusk, mammal, and bird, in addition to fish. I looked for changes in the general composition of the Kohala faunal assemblage, comparing the amounts of fish, mollusk, mammal, and bird in the diet through time. NISP and weight for fish, mollusk, bird, and mammal were recorded previously in the laboratory. For mollusks these had been further identified to genus and species when possible. Mammals had been identified to species when possible, or to small or medium mammal categories. Birds were very rare in the faunal assemblage, and when identified were recorded as bird. I combined these categories to yield very broad categories of all fish, mollusk, mammal, and bird.

Figure 4.33 compares the NISP and MNI of all fish remains from Kohala. The decreases in the second and fourth periods most likely reflect sampling issues and not declines in fish consumption in prehistory (there were very few excavation units that dated to this period) (see Field et al. 2008, 2009, 2010a). This also appears to be true when NISP and weight of the all fauna in the Kohalan assemblages are compared. Figure 4.34a shows the combined NISP of all fauna in Kohala, and figure 4.34b showed the combined weights. The faunal densities show the proportion of each faunal type in the recovered faunal assemblages (Figure 4.35). Through time, more mollusks, less fish, and slightly more mammal occur in the assemblages. These numbers may not reflect the exact proportions of each food type in prehistoric diets, but they are assumed to accurately reflect general patterns of subsistence in prehistory. The primary concern is an artificial appearance of an overabundance of mollusk compared to fish, due to their greater weight, and an appearance of an overabundance of fish due skeletal anatomy and the degree of fragmentation of the ichthyofaunal assemblage. However, the general pattern of more mollusk, more mammal, and less fish through time is seen in both the NISP and weight calculations. This suggests that more households were gathering more mollusks later in time, and the importance of mollusks in the diet was increasing.

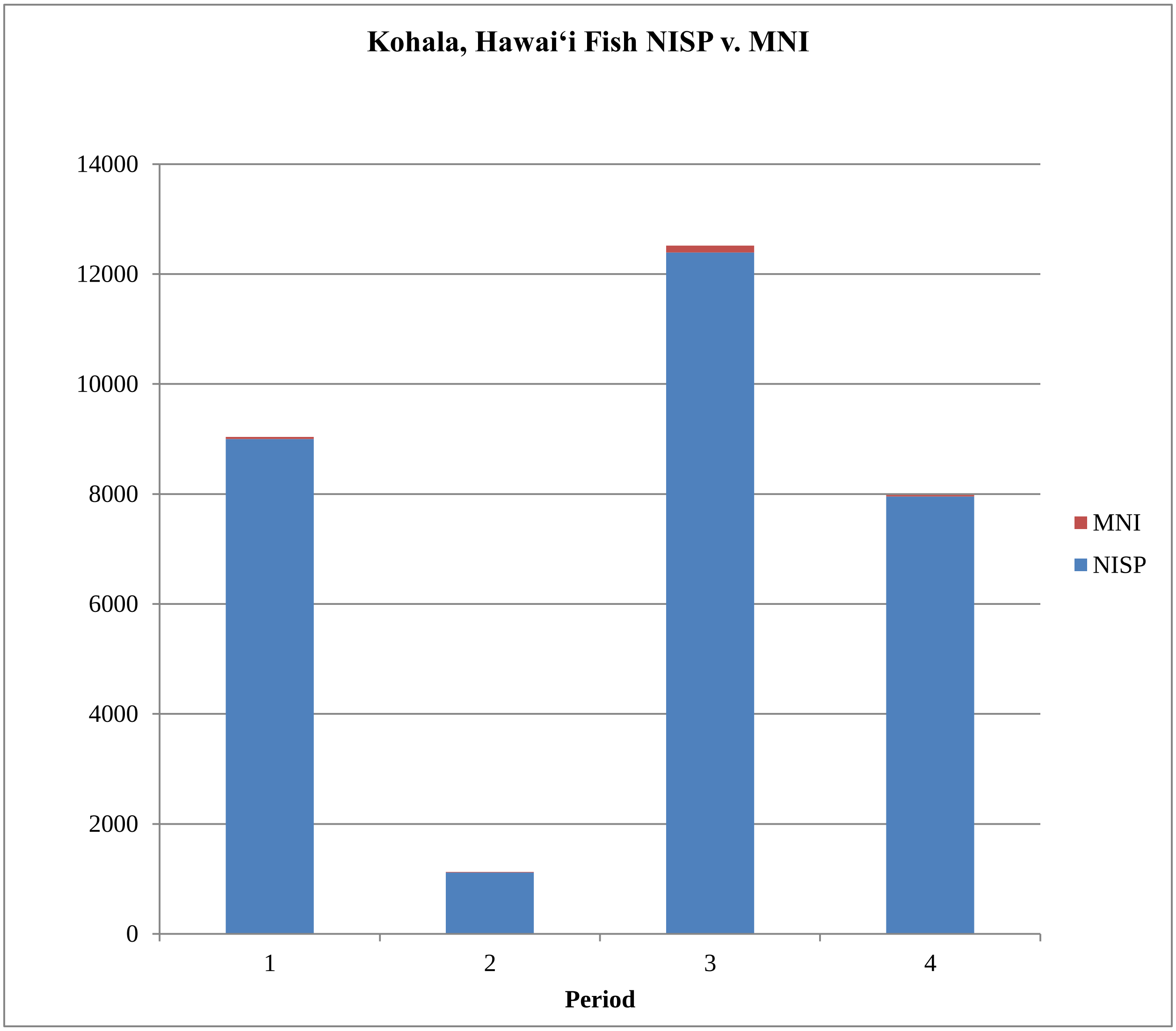


Figure 4.33. A comparison of NISP and MNI of fish in the Kohalan assemblage.

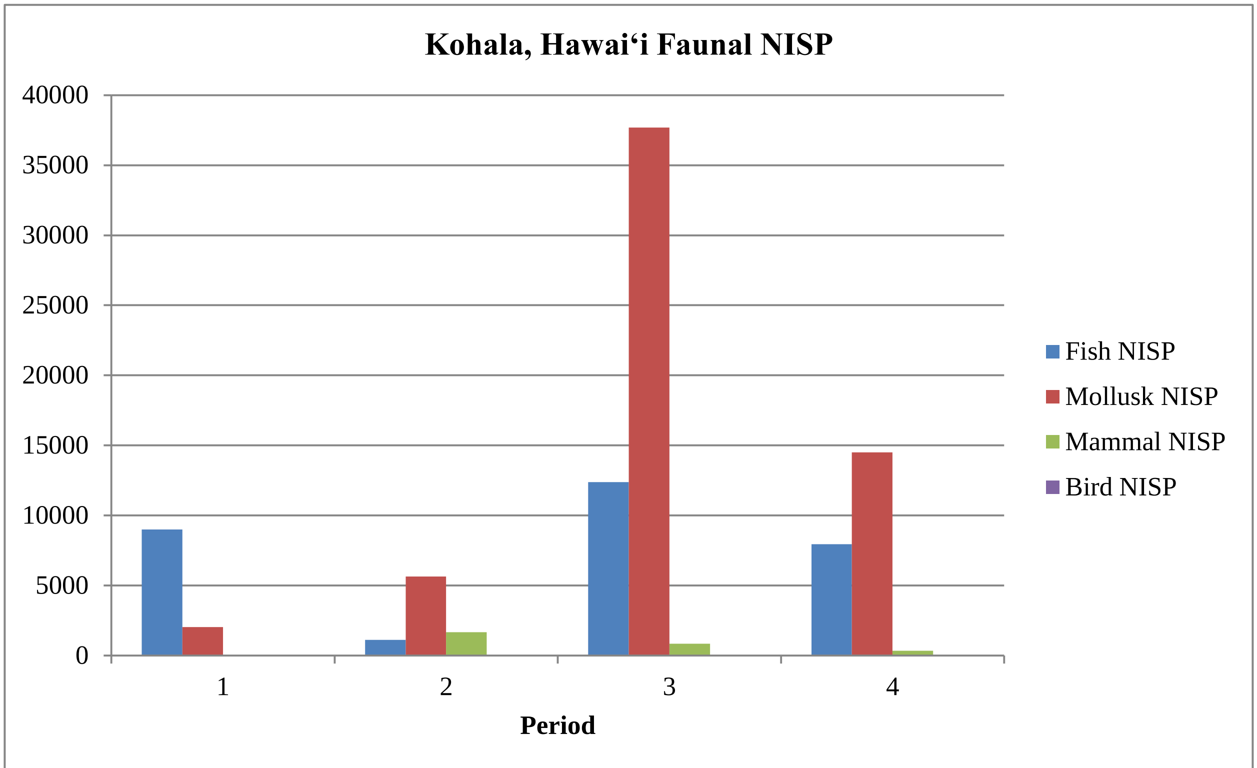


Figure 4.34a. The NISP of the entire Kohalan faunal assemblage.

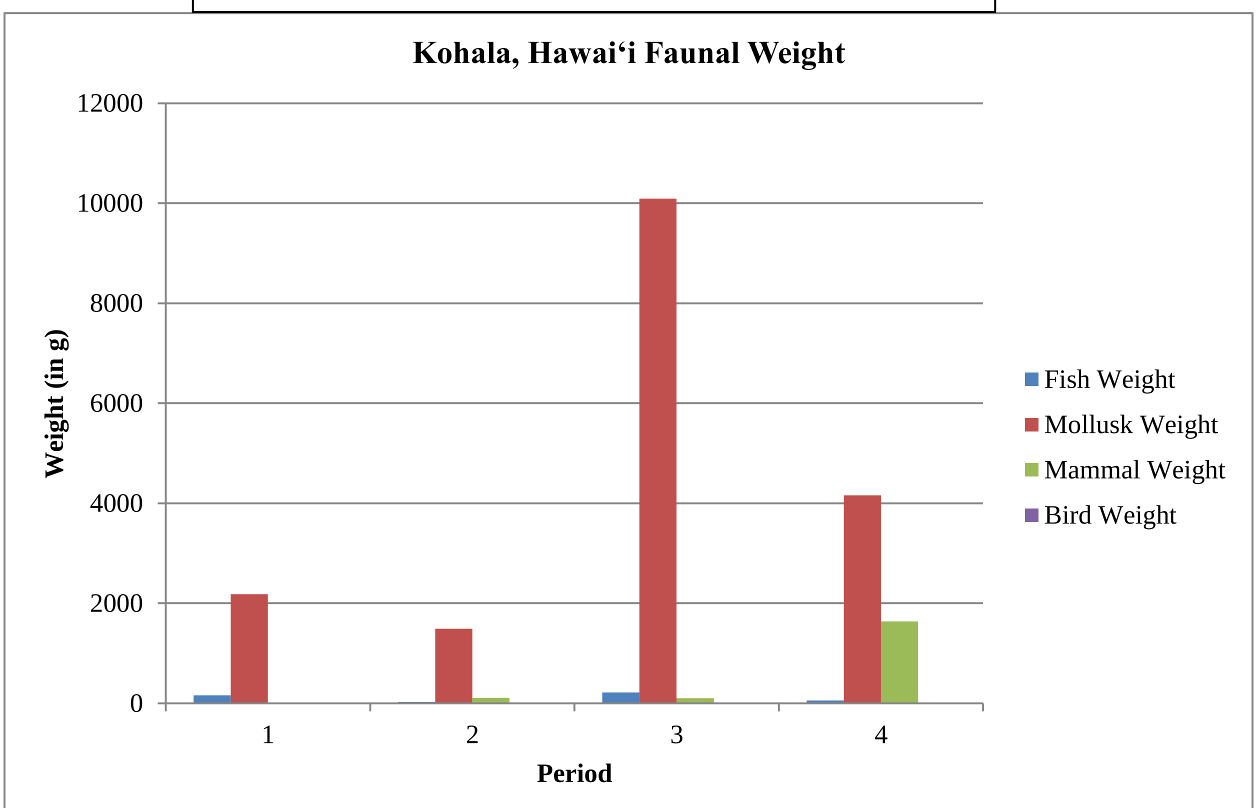


Figure 4.34b. The weights of the entire Kohalan faunal assemblage.

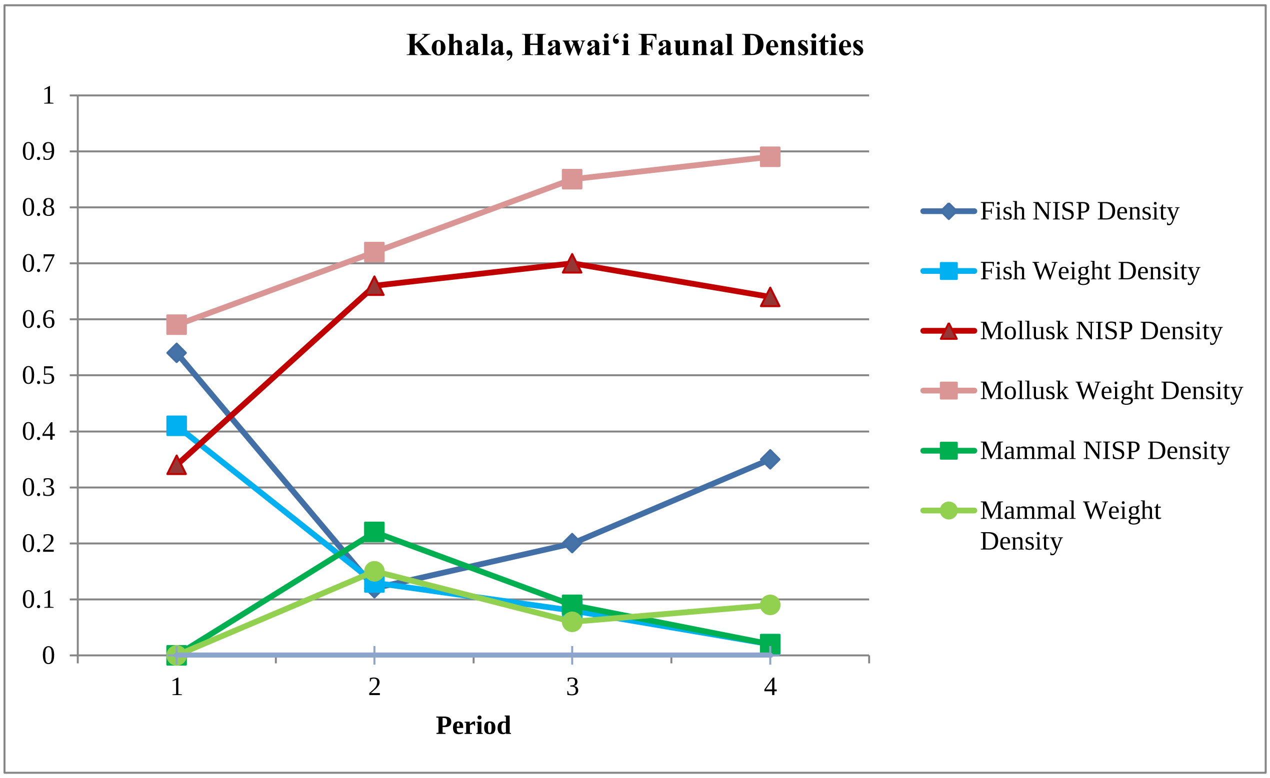


Figure 4.35. The faunal densities for Kohala.

In contrast, the evenness values do not reflect the same patterns. When using NISP, the evenness appears to increase, reflecting a more equal amount of faunal materials in the assemblage. However, this trend is not significant ($p>.05$). Using weight calculations, the evenness appears to decrease, reflecting an increasing focus on one type of faunal remain in the assemblage (Figure 4.36). This trend is also not significant ($p>.05$). Figure 4.37 these results in a simplified manner, using the average evenness values.

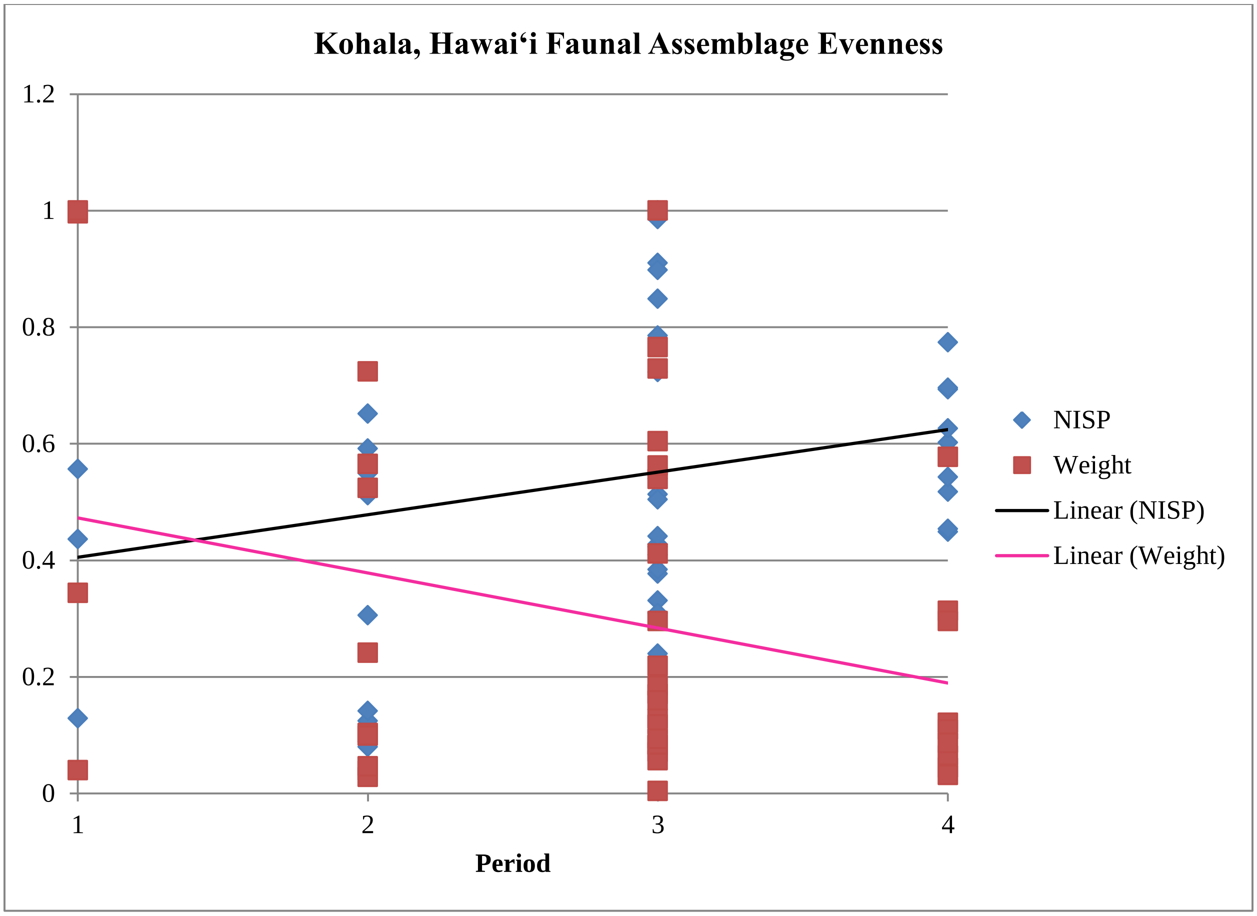


Figure 4.36. The NISP and weight evenness values for the Kohalan faunal assemblage.

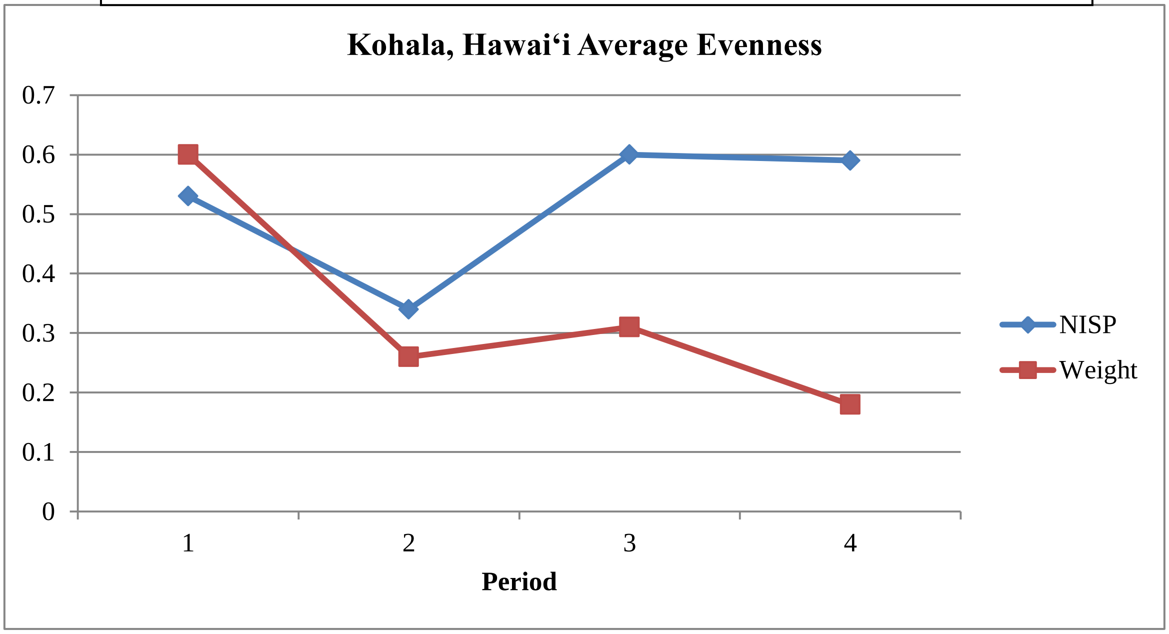


Figure 4.37. The average evenness values for Kohala, using NISP and weight.

Coastal Assemblages vs. Upland Assemblages

Several aspects of the fish assemblage were used in comparisons of faunal material from the coastal residences to the field system (upland) residences. The differences between the NISP of identified fish (Figure 4.38), NTAXA, and evenness of the identified ichthyofaunal assemblage (figure 4.39), fish NISP (figure 4.40a), fish weight (figure 4.40b) and the proportions of fish by NISP and weight (figure 4.41) were tested for significance in each temporal period. The differences between the coast and upland were not statistically significant in the first and second temporal periods. In the third temporal period, the NTAXA, NISP of identified fish, and weight of the fish were significantly different ($p<.05$) between the coast and the field system. The coastal sites do show a larger number of identified taxa (Table 4.5). Four of the five highest ranked taxa are identified in upland sites, and the taxa found in the uplands are generally larger-bodied families (*Scombridae* spp., *Scaridae* spp., *Carangidae* spp.). This list is all four periods combined, and the only period in which the difference between NTAXA of the coastal and upland sites was significant was in the third period.

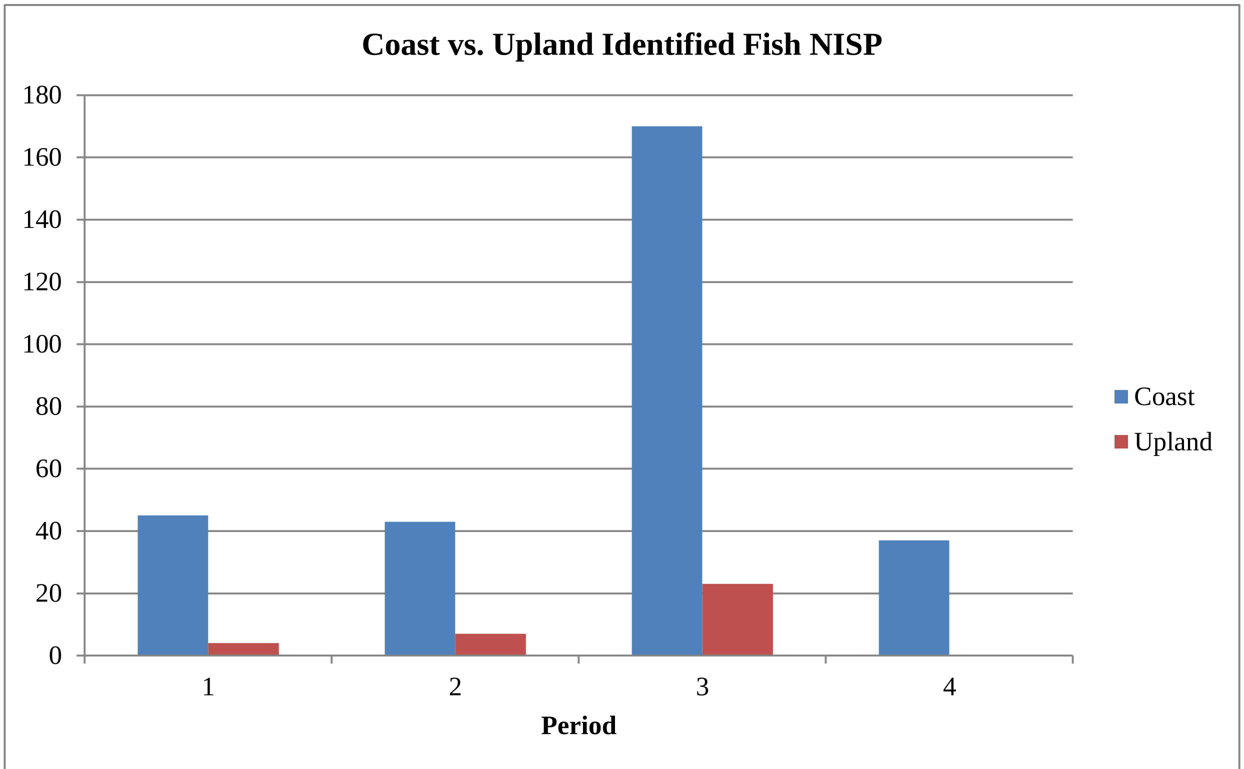


Figure 4.38. The NISP of identified fish in coastal and upland sites.

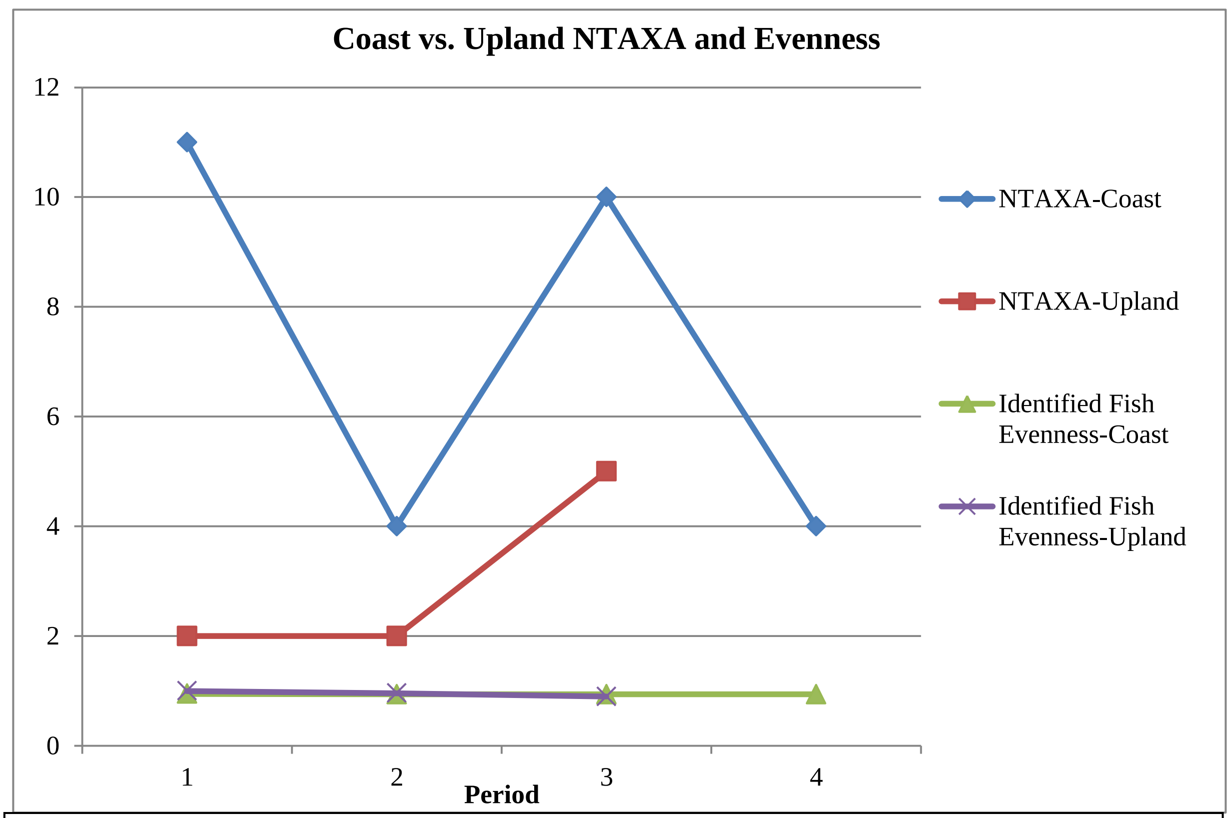


Figure 4.39. NTAXA and evenness of the identified icthyofaunal assemblage for coastal and upland sites.

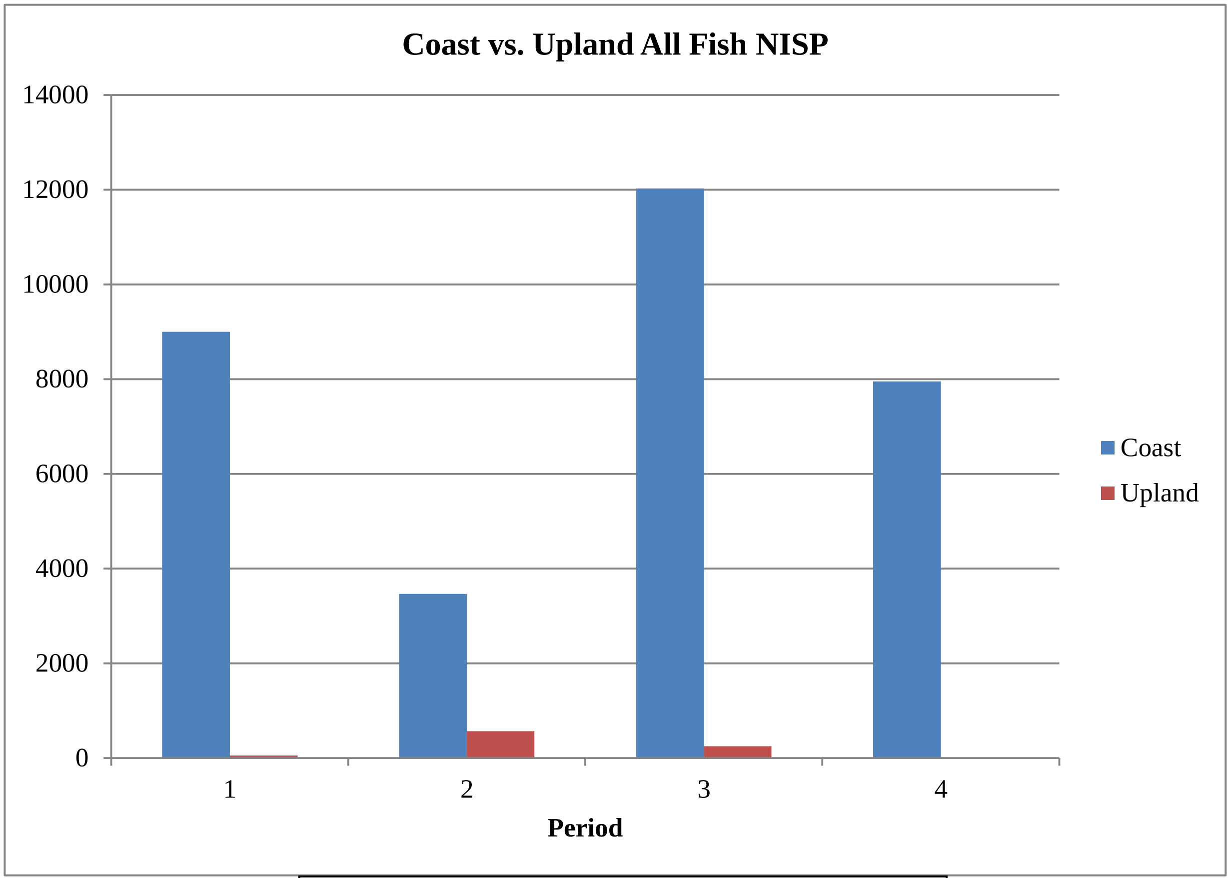


Figure 4.40a. Fish NISP for coastal and upland sites.

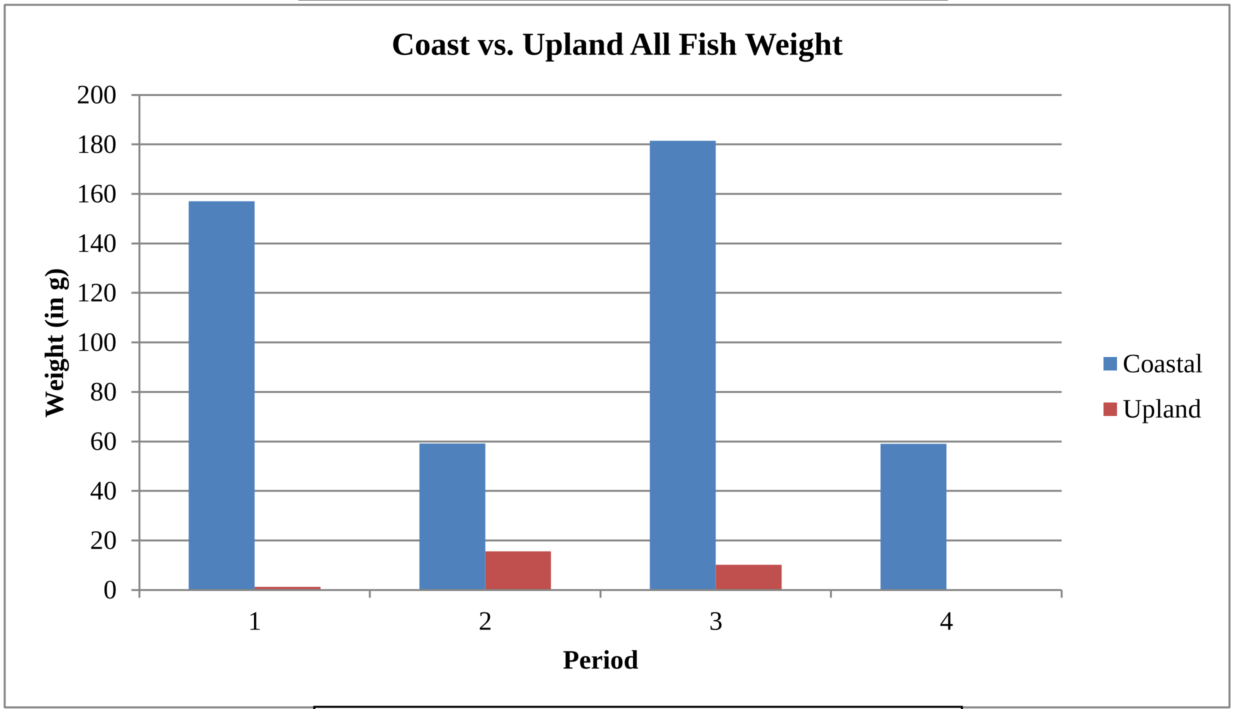


Figure 4.40b. Fish weight for coastal and upland sites.

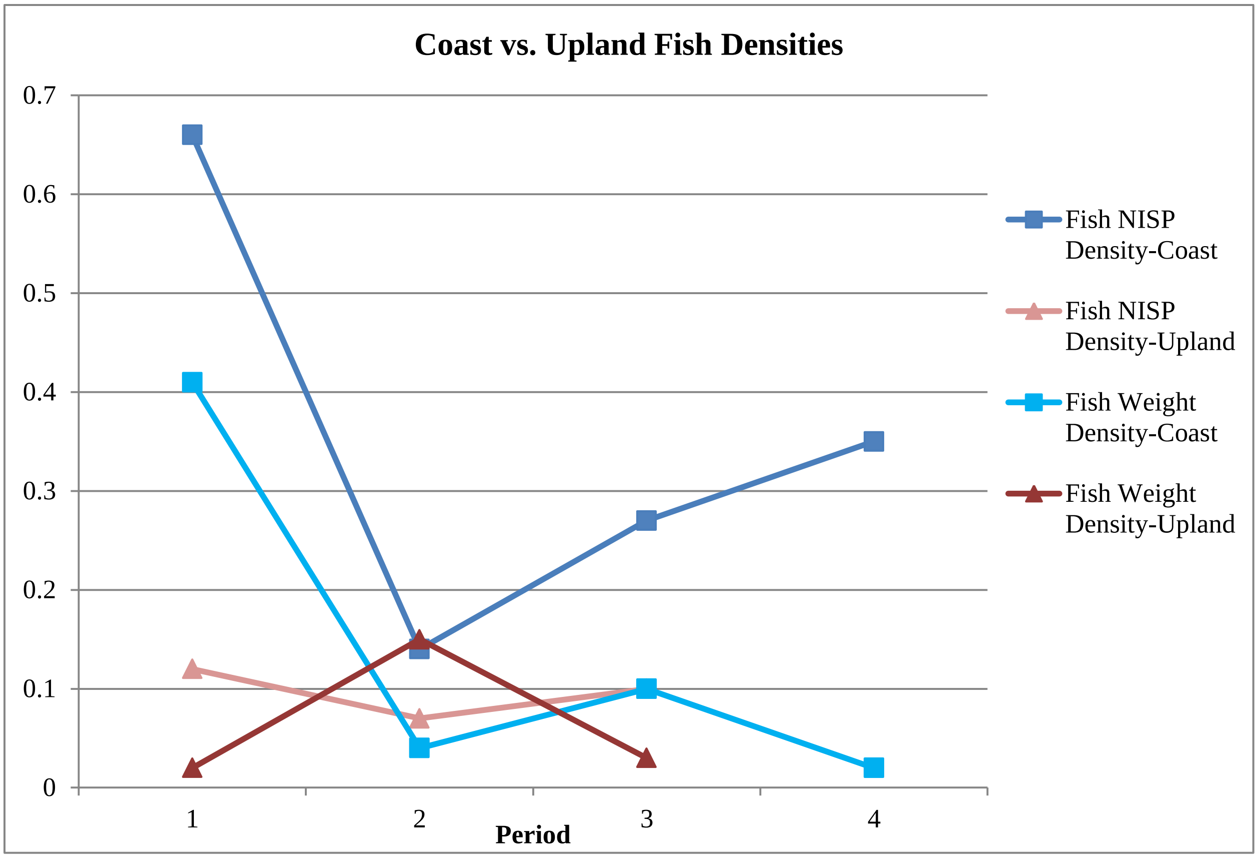


Figure 4.41. Proportions of fish, by NISP and weight, within the total faunal assemblage for coastal and upland sites.

Identified Taxa in Coastal Sites	**Identified Taxa in Upland Sites**
Acanthuridae spp.	
Balistidae spp.	*Balistidae* spp.
Belonidae spp.	
Carangidae spp.	*Carangidae* spp.
Coryphaenidae spp.	
Diodontidae spp.	*Diodontidae* spp.
Holocentridae spp.	
Kyphosidae spp.	
Labridae spp.	*Labridae* spp.
Lutjanidae spp.	*Lutjanidae* spp.
Monacanthidae spp.	
Mullidae spp.	*Mullidae* spp.
Muraenidae spp.	
	Ostraciidae spp.
Pomacentridae spp.	
Priacanthidae spp.	
Scaridae spp.	*Scaridae* spp.
Scombridae spp.	*Scombridae* spp.
Scorphaenidae spp.	
Serranidae spp.	
Tetradontidae spp.	

Table 4.5. Identified taxa in coastal and upland sites.

Brief Summary of Results

As a result of these analyses it can be stated that common reef fish were exploited by prehistoric peoples living throughout Kohala, Hawaiʻi. There is no evidence for resource depression occurring during any temporal period in Kohala, with the exception of a significant decrease through time in the size of *Calotomus* sp. upper pharyngeal plates. The other significant changes throughout the assemblage were a decrease in NTAXA in the *ahupuaʻa* of Kālala, a decrease in the evenness in Makeanehu, and a decrease in NTAXA in Makiloa. These decreases indicate that the diet was possibly becoming more focused on particular taxa over time. The general faunal assemblage from Kohala indicates that there was great variability with regards to general faunal exploitation over space (between *ahupuaʻa* and between the coast and the field system). My analyses suggest that over time, more marine resources were being used and certain food types, especially mollusk, were becoming more important.

Chapter 5: Discussion

Part 1: Marine Resource Use Through Time in Kohala

Did Resource Depression Occur in Prehistory?

The results of my analysis yielded a small number of identified fish for each site; therefore I have combined the results from contemporary sites so I can analyze general trends within each *ahupuaʻa* and throughout Kohala. Overall, these analyses do not provide evidence for resource depression in fish populations in prehistoric Kohala, and there are no significant changes seen in the combined ichthyofaunal assemblage. The prey index examination does not decrease significantly through time, the NTAXA and evenness values of each *ahupuaʻa* do not increase significantly, nor does the average size of fish decrease significantly through time.

Both families used in the prey index examination (*Labridae* spp. and *Scaridae* spp.) are ubiquitous from AD 1400-1800. Although for statistical purposes, *Labridae* spp. has been deemed "low-ranked" due to its smaller size, it was commonly utilized throughout Kohala and the Hawaiian archipelago (Kirch 1979). *Labridae* spp. was common throughout assemblages in each time period and in each *ahupuaʻa*; thus its use in prehistory does not seem to have been a reaction to decreases in other fish species.

As far as the richness of the fish assemblage, the earliest assemblages in Pahinahina show a large diversity of species utilized. The NTAXA of PHH-13 was 11 families, and this assemblage included reef-dwelling and pelagic species. The wide range of fish used also implies that the people who settled the earliest sites along the coast brought with them ecological knowledge from a long tradition of fishing in Eastern Polynesia, and likely adjusted quickly to efficiently fish the waters off Kohala (Goto 1984). In general, the trends in NTAXA of each *ahupuaʻa* from AD 1650-1800 show a sizeable diet breadth (though this increase is not statistically significant, because of the large NTAXA of PHH-13). One problem with the results of the statistical analysis could be the inclusion of the sites of MKI-56 and PHH-13, which might be inflating the NTAXA for periods 3 and 1, respectively. However, when these sites are removed from the dataset and the ANOVA is performed again, the NTAXA still does not significantly change through time ($p=0.156$). The only significant changes in diversity analyses yield results that are opposite of what is expected if resource depression is occurring: a decrease in the NTAXA of Kālala and Makiloa, and a decrease in evenness in Makeanehu.

Similarly, the results of Shannon's evenness indices do not support an argument for changing diet breadth over time in Kohala. Though a significant decrease is seen in Makiloa, the evenness value for each assemblage was typically high (close to 1). This is because the NISP and MNI of the identified assemblage for each site were small on average; average NISP was 8, and MNI was 5. If the sites had larger identified assemblages, and if there were some multi-component sites, the Shannon's Evenness Index would have provided more insight into prehistoric diet breadth.

In addition, the tests on average sizes of different fish indicated only one significant decrease in the size of *Calotomus* sp. upper pharyngeal plates. For each element tested, the range of element sizes was large, and not clustered around the mean (Figures 4.26-4.32). This is most likely due to the wide range of sizes within genera. On average, *Scaridae* spp., depending on the species, ranges from approximately 14-30 inches, *Balistidae* spp. to approximately 10-12 inches, *Labridae* spp., depending on the species, from 7 to 20 inches, and *Monacanthidae* spp. range from approximately 5-7 to 24 inches (Hoover 2003). There can also be a great amount of variability within genera, in terms of size. Unfortunately, it is often impossible to identify ichthyofaunal remains to a lower taxonomic level than family (e.g., genus, or species). The small sample size used in my analysis, with the high variability present in fish populations, makes the tests for changes in size over time inadequate for conclusive results.

Discussion of the Complete Faunal Assemblage

Examining the complete faunal assemblage for Kohala can provide insight into general changes in animal use in prehistory. Throughout Kohala, there an increase in the amount of residential structures from AD 1650-1800, and an increase in the total amount of fish remains and faunal material recovered from these excavations (Field et al. 2011). The amount of marine foods, especially mollusk, increased. The densities of different fauna within the assemblages show this pattern. The patterns differ by examination using weight or count, but the same general trend of increasing proportions of mollusk in the Kohala assemblages emerges; this is reflected in the evenness values for all of Kohala. When the complete faunal assemblage is analyzed, the evenness values are smaller than those seen for the ichthyofaunal assemblage. All are on average less than 0.6 (Figure 4.37).

There was a lesser amount of faunal material recovered from the upland sites than coastal sites, but the presence marine foods in upland sites shows that marine resources were being transported into the LKFS. With the exception of *Ostraciidae* spp. (boxfish) and *Mullidae* spp. (eel), all the identified fish in upland sites were those of larger-bodied families, and belonged to families which have been previously identified as highly ranked in this analysis. The presence of these taxa in the upland sites reinforces the determined rankings for coastal sites; only the more desirable fish were transported many kilometers inland to homes within the LKFS.

The quantity of excavation units introduced a lot of variation into the statistical analysis, and because of this variation, few statistically significant trends could emerge. There are a few general trends which are displayed, but there is much variability spatially and temporally.

Though the data set is small, the general patterns of exploitation complement other information about subsistence in Leeward Kohala, with population and consumption of marine resources increased from AD 1400-1800. While agricultural production was increasing later in prehistory, fishing and other marine resources were not declining in importance. The decrease in faunal material from AD 1800-present coincides with the historically described population decrease throughout the archipelago after European contact (Kirch 2010).

Natural Resource Management

If resource depression is recorded in the archaeological record, it provides archaeologists with insights into prehistoric strategies of natural resource management, or mismanagement. However, instances when resource depression does not occur in prehistory are also insightful; these cases are often "cited as examples of conservation and resource management" (Lyman 2003: pg. 376). The lack of resource depression in Kohala does not necessarily mean that prehistoric populations were actively practicing conservation strategies, although traditional conservation strategies have been documented historically in Hawai‘i (Jokiel et al. 2011).

Resources in prehistoric Hawai‘i were controlled by the chiefs and land managers (*ali‘i* and *konohiki*, respectively) (Kirch 2010). Surplus marine and agricultural goods were required of local populations; however it does not appear that the demand for fish, for ritual activity and for everyday consumption, overtaxed the Kohalan marine ecosystem. If the Hawaiian socio-political trajectory had not been altered by the arrival of the Europeans, it would be interesting to see if resource management by the elites did result in overharvesting and resource depression later in Kohala's history.

Zooarchaeological studies of resource depression can also be applied to modern biological conservation issues (Lyman and Cannon 2003). Zooarchaeological studies provide biologists with a long-term record of animal populations, and can explore the effects that human populations have had on those populations (Butler and Delacourte 2003). Human predation can have an effect on animal body size, but a key concern in conservation studies is biogeography, or the species distribution (Whittaker and Fernández-Palacios 2007). By examining modern and historical species ranges, scientists, armed with more complete information, can formulate more effective conservation strategies.

Modern studies of fish biogeography and ecology could incorporate archaeological data into their analysis. For example, a recent study of *Scaridae* spp. ecology in Hawai‘i examined "current parrotfish distributions, size structure, species composition and associated habitats" (Howard et al. 2009: pg. 175). Though the archaeological record is an incomplete picture of community paleoecology, it can still inform generally upon community composition and distribution, and the size of fish. The results of studies such as the one conducted by the Hawai‘i Coral Reef Assessment and Monitoring Program (2002) can be compared to the results of archaeological projects to examine continuity in community composition. Future work in refining ichthyofaunal identifications could also aid in examining long-term community composition. These studies can provide long-term perspective on conservation planning, aiding in answering questions such as "which taxa are native, which are exotic, which should be targeted for recovery, and which should be disregarded" (Butler and Delacourte 2004: pg. 26).

Part 2: Limitations of This Analysis

The biggest potential problem with this analysis was whether the results are actually representative of prehistoric diet and fishing strategies, or if they are biased in some way.

Sampling

O'Leary (2011) has shown that the results of icthyofaunal analysis can be highly dependent on sample size. His discussion of sampling shows that the recovery and identification of fish is dependent on mesh size and depth of the archaeological deposit (see also Nagaoka 2005). Field and colleagues used 1/8" and 1/16" screen during all excavations, and a number of baulk soil samples were collected and later sorted by hand in the laboratory (Field et al. 2008, 2009, 2010a). I was able to identify fish remains from both screen sizes. However, these were often fragmentary remains of more easily identifiable "special bones", but in addition, a number of identifiable elements from the jaws of small-bodied families were recovered (e.g., *Acanthuridae* spp., *Belonidae* spp., see Appendix 4).

Since the sample size of the Kohala identified assemblage is very small, it is likely that these results are dependent on sample size as well. However, the nature of the excavations in Kohala is different from those discussed by O'Leary (2011). O'Leary examined a large fish assemblage from two deeply stratified units at a single site. The identified fish from Kohala were distributed throughout the *ahupua'a* in many small household units. Despite these limitations, the tests for resource depression were still conducted on the identified icthyofaunal assemblage. The analysis conducted on the general faunal assemblage used a large enough data set that the results can be used to discuss patterns of faunal exploitation with a greater degree of confidence on the macroscale level for Kohala.

Problems in Faunal Analysis

The zooarchaeological record can be very fragile; bone is organic and does not often preserve well. In the Kohala assemblage, the entire faunal assemblage, and especially the fish, was extremely fragmentary, making identification difficult. There were many fish skeletal elements which were "possibly identifiable" upon my initial analysis, but ultimately were unable to be identified due to incompleteness and the lack of an extensive reference collection in the laboratory. The Dye and Longenecker (2004) manual has an extensive collection of photographs to aide in identification, but pictures do not compare with being able to do side-by-side comparisons with reference bones. A larger reference collection may have boosted the amount of fish able to be positively identified, but the best Pacific fish reference collections are located in the Pacific, and there are logistical and monetary issues with accessing those collections.

Another issue common to all of zooarchaeology is the possibility of over-representation of certain species. Not all species of animal, including fish, have the same number of bones. Some fish have "special bones", which can inflate their abundance in faunal assemblages (O'Leary 2011). *Scaridae* spp., *Labridae* spp., *Balistidae* spp., *Monacanthidae* spp. and *Diodontidae* spp. (the most common fish identified in this analysis) all have special bones. These bones also are more robust than other fish skeletal elements, and have a preservation bias in the archaeological record (Nagaoka 2005). *Diodontidae* spp. can have hundreds of skeletal spines in their skin. Using NISP, these fish could easily be assumed to dominate an assemblage. Using a determination of MNI, this number is typically drastically reduced (see Figure 4.6a and 4.6b). This is a prime example of why NISP and MNI are both used in analysis and reported in zooarchaeological analysis (for a detailed discussion of NISP and MNI see Grayson 1984).

Household Archaeology

The unit of analysis for this project is not a small number of large excavation units with deep cultural deposits, but small excavation units, primarily in household complexes, with shallow cultural deposits. This is not the ideal situation for detailed faunal analysis, since the study area is not one site but many sites over a broad geographic area. This analysis does not allow for detailed examination of changes at the microscale level, as an extensive excavation of one larger site would (see O'Leary 2011; Fitzpatrick et al. 2011; Weisler et al. 2011). The results must be examined at the macroscale level, to reveal broader regional patterns.

Chapter 6: Conclusion

Zooarchaeological studies can help archaeologists better understand the role that fish and fishing played in the diet and subsistence of prehistoric Hawaiians. Ichthyofaunal remains from residential sites provide insight into what the *makaʻāinana* (commoners) were consuming, and what was being provided as surplus to the *aliʻi* (chiefs). The Hawaiian socio-political structure and heavy use of marine resources prompts an investigation into the possibility of resource depression in prehistory, so archaeologists can better understand resource management in this hierarchical system.

The ichthyofaunal assemblages generated from the excavation of residential sites that date from AD 1400-1800 were examined. Statistical tests for resource depression were also conducted on the identified assemblages. General patterns reflect a high usage of near-shore fish throughout prehistory, and an increase in the amount of fish consumed over time. However, diet breadth as it pertains to fish does not change significantly, although it included more mollusks over time. These results concur with an increase in all types of food production in Kohala from AD 1400-1800. There is no evidence for resource depression in any *ahupuaʻa* or in Kohala in general, at any time period.

It is important to note that the question of resource depression in Kohala has not been completely answered with these analyses. The next step in examining marine resource use in Kohalan prehistory is a detailed analysis of patterns of mollusk exploitation over time, which will provide a larger data set for the analysis of marine use in prehistory. In addition, the excavation of sites with deeper cultural deposits, and much larger excavation units, would allow for examination of changes at the household level, instead of the generalized regional level employed in this analysis.

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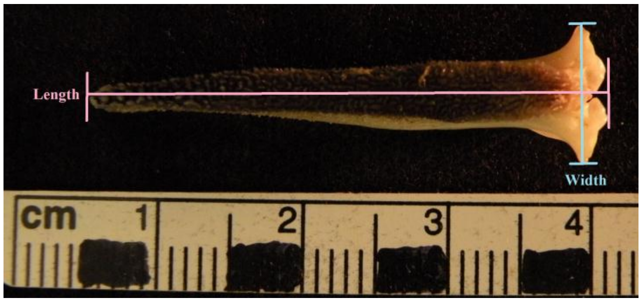
Appendix 1

Example of recording spreadsheet

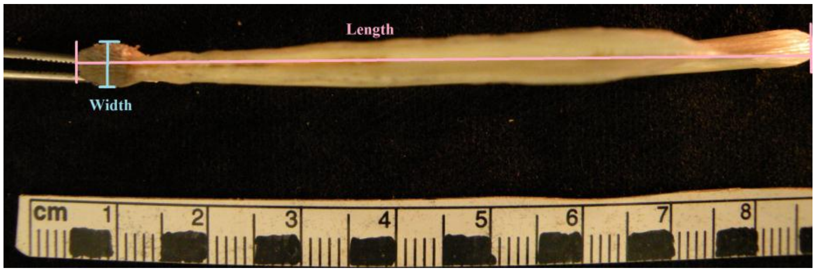
Unit	Period	Family	Genus	Species	Element	Side	Length	Lcomp?	Width/Height	Wcomp?	ETL L	ETL W

Appendix 2

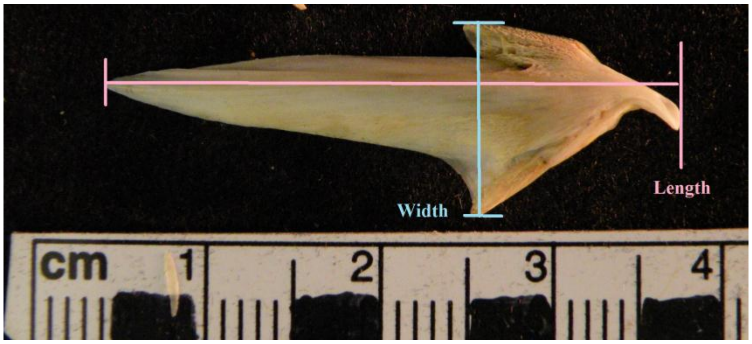
Examples of how each type of element was measured.



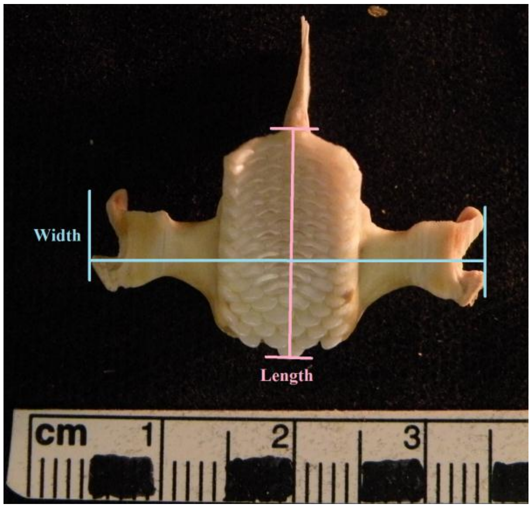
First dorsal spine (*Balistidae* spp.). Photo by Jacqueline Lipphardt



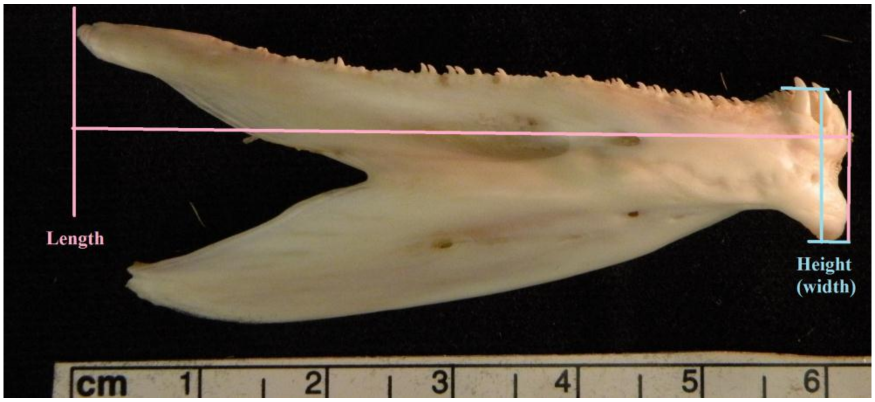
Pelvis (*Balistidae* spp.) Photo by Jacqueline Lipphardt.



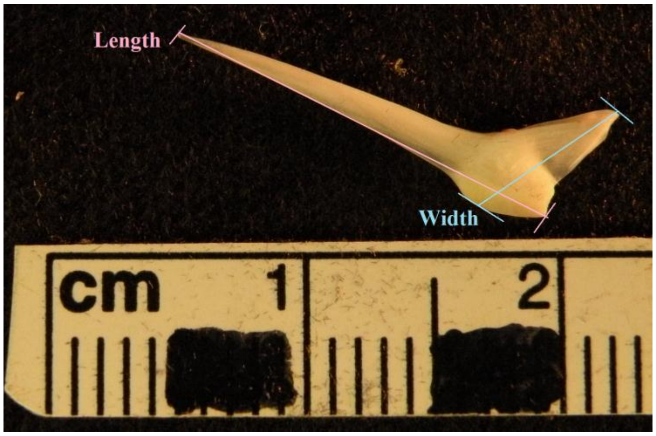
Right angular (*Scombridae* spp.).
Photo by Jacqueline Lipphardt.



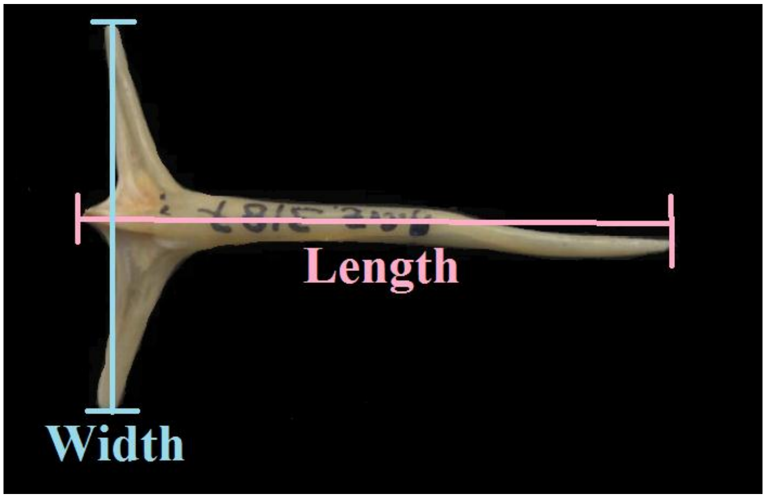
Lower pharyngeal (*Scaridae* spp.)
Photo by Jacqueline Lipphardt.



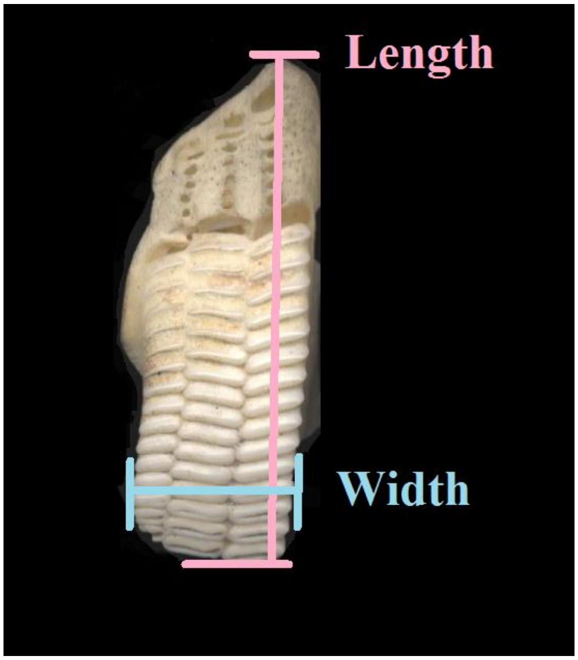
Right dentary (*Serranidae* spp.). Photo by Jacqueline Lipphardt.



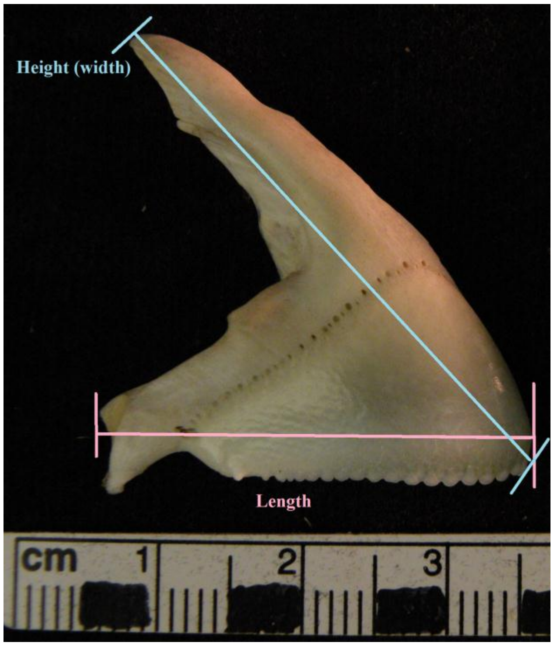
Second dorsal spine (*Balistidae* spp.).
Photo by Jacqueline Lipphardt.



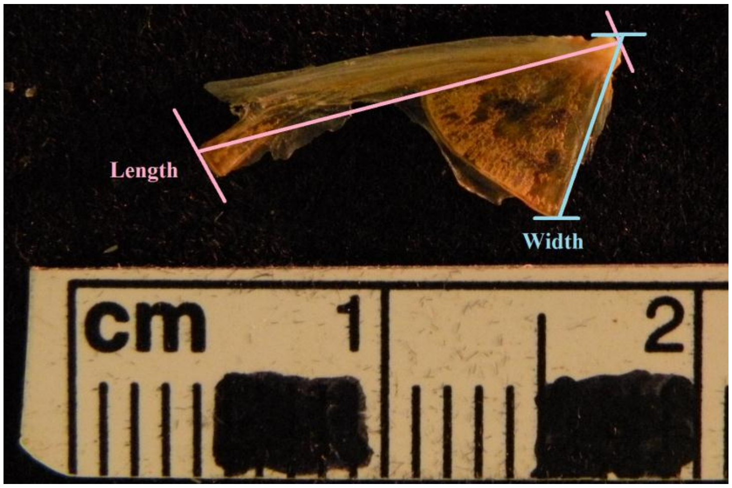
Spine (*Diodontidae* spp.).
Photo from Dye and Longenecker (2004).



Left upper pharyngeal (*Scaridae* spp.).
Photo from Dye and Longenecker (2004).

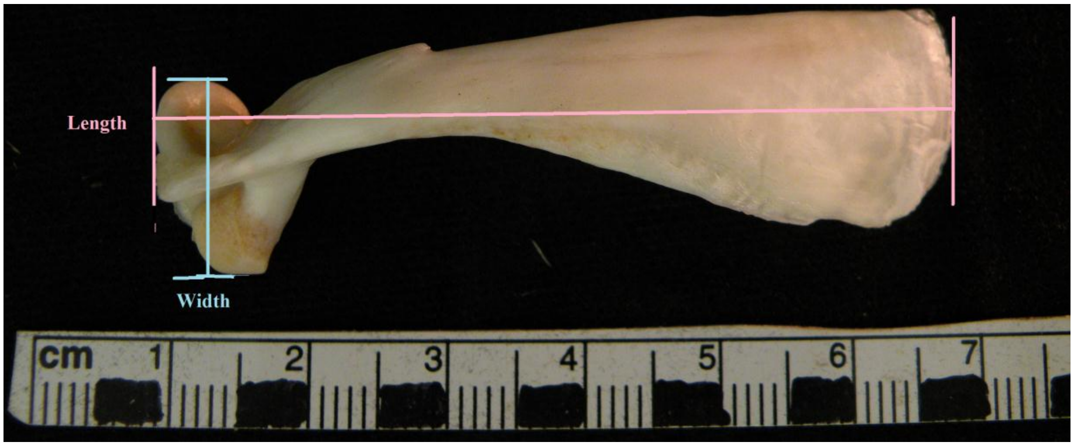


Right premaxilla (*Scaridae* spp.).
Photo by Jacqueline Lipphardt.



Right quadrate (*Balistidae* spp.).
Photo by Jacqueline Lipphardt.

Pterygial carina (*Balistidae* spp.). Photo by Jacqueline Lipphardt.



Left maxilla (*Serranidae* spp.). Photo by Jacqueline Lipphardt

Appendix 3

List of excavation units with faunal material

Excavation Unit	Period	Identified Fish?
KAL-10A-TU1	4	X
KAL-10A-TU2	4	X
KAL-10B-TU3	4	X
KAL-10C-TU4	4	X
KAL-10C-TU5	4	X
KAL-10C-TU6	ND	X
KAL-1-TU1	1	
KAL-23A-TU1	4	
KAL-23A-TU3	4	X
KAL-23B-TU2	4	X
KAL-30A-TU1A	2	X
KAL-30A-TU1B	2	
KAL-30A-TU1-BAULK	2	X
KAL-30B-TU2	3	X
KAL-30B-TU2-BAULK	3	X
KAL-5A-TU1	3	X
KHL-10-TU1	2	
KHL-12-TU1	2	
KHL-1-TU1	3	
KHL-2A-TU1	2	X
KHL-2B-TU4	ND	X
KHL-2D-TU2	3	X
KHL-2D-TU3	3	X
KHL-48-TU1	3	
KHL-50-TU1	ND	
KHL-50-TU2	ND	
MKE-103-TU1	2	X
MKE-103-TU2	ND	X
MKE-104-TU1	2	X
MKE-105-TU1	2	X
MKE-106-TU1	1	X
MKE-107-TU1	ND	X
MKE-108A-TU1	3	X

Excavation Unit	Period	Identified Fish?
MKE-108B-TU2	ND	X
MKE-1-TU3	ND	X
MKE-2A-TU1	3	
MKI-11A-TU1	3	X
MKI-13-TU1	ND	
MKI-198B-TU1	3	
MKI-199A-TU1	2	
MKI-1A-TU1	3	X
MKI-1A-TU3	ND	
MKI-23A-TU1	3	X
MKI-23A-TU2	ND	
MKI-24-TU1	ND	X
MKI-24-TU2	ND	
MKI-25B-TU3	3	X
MKI-25A-TU1	ND	X
MKI-25A-TU2	ND	X
MKI-2A-TU1	2	X
MKI-2A-TU2	2	X
MKI-2C-TU3	3	X
MKI-300-TU1	3	X
MKI-301A-TU1	3	X
MKI-301A-TU2	2	X
MKI-303-TU1	1	X
MKI-304A-TU1	3	X
MKI-306-TU1	3	X
MKI-307-TU1	3	
MKI-378A-TU1	2	X
MKI-378B-TU2	ND	X
MKI-378C-TU3	ND	X
MKI-414-TU1	3	X
MKI-56-TU1	3	X
PHH-13A-TU1	1	X
PHH-30-TU1	1	X

Appendix 4

Complete table of identified ichthyofaunal material

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
61	Habitation	Coastal	4	KAL-10A-TU1-1-5	199943.0183	2223666.453	Scaridae		
250	Habitation	Coastal	4	KAL-10A-TU1-1-6	199943.0183	2223666.453	Scaridae	Calotomus	
251	Habitation	Coastal	4	KAL-10A-TU1-1-6	199943.0183	2223666.453	Monacanthidae		
105	Habitation	Coastal	4	KAL-10A-TU1-2-2	199943.0183	2223666.453	Monacanthidae		
287	Habitation	Coastal	4	KAL-10A-TU1-2-2	199943.0183	2223666.453	Labridae		
276	Habitation	Coastal	4	KAL-10A-TU1-2-6	199943.0183	2223666.453	Monacanthidae		
277	Habitation	Coastal	4	KAL-10A-TU1-2-6	199943.0183	2223666.453	Scaridae		
101	Habitation	Coastal	4	KAL-10A-TU2-2-6	199943.0183	2223666.453	Scaridae		
102	Habitation	Coastal	4	KAL-10A-TU2-2-6	199943.0183	2223666.453	Scaridae		
56	Indetermined	Coastal	4	KAL-10B-TU3-1-3	199957.6624	2223649.999	SCARIDAE	CALOTOMUS	
107	Indetermined	Coastal	4	KAL-10B-TU3-1-3	199957.6624	2223649.999	Labridae		
166	Indetermined	Coastal	4	KAL-10B-TU3-1-3	199957.6624	2223649.999	Scaridae	Calotomus	
248	Indetermined	Coastal	4	KAL-10B-TU3-2-3	199957.6624	2223649.999	Lutjanidae		
272	Indetermined	Coastal	4	KAL-10B-TU3-2-3	199957.6624	2223649.999	Unidentifiable		
148	Habitation	Coastal	4	KAL-10C-TU4-2-3	199927.2875	2223645.974	Scaridae	Calotomus	
108	Habitation	Coastal	4	KAL-10C-TU4-3-2	199927.2875	2223645.974	Scaridae	Calotomus	
278	Habitation	Coastal	4	KAL-10C-TU4-3-2	199927.2875	2223645.974	Labridae		
238	Habitation	Coastal	4	KAL-10C-TU5-1-2	199927.2875	2223645.974	Muraenidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
106	Habitation	Coastal	4	KAL-10C-TU5-2-1	199927.2875	2223645.974	Diodontidae		
196	Habitation	Coastal	4	KAL-10C-TU5-3-3	199927.2875	2223645.974	Labridae	Thalassoma	duperrey
100	Habitation	Coastal	4	KAL-10C-TU6-1-7	199927.2875	2223645.974	Tetradontidae		
211	Habitation	Coastal	4	KAL-10C-TU6-2-2	199927.2875	2223645.974	Labridae	Thalassoma	duperrey
279	Habitation	Coastal	4	KAL-10C-TU6-2-7	199927.2875	2223645.974	Labridae		
99	Habitation	Coastal	4	KAL-10C-TU6-3-3	199927.2875	2223645.974	Balistidae		
236	Habitation	Coastal	4	KAL-10C-TU6-3-3	199927.2875	2223645.974	Labridae		
237	Habitation	Coastal	4	KAL-10C-TU6-3-3	199927.2875	2223645.974	Labridae		
7	Habitation	Coastal	4	KAL-10C-TU6-3-7	199927.2875	2223645.974	SCARIDAE	CALOTOMUS	
24	Habitation	Coastal	4	KAL-10C-TU6-3-7	199927.2875	2223645.974	LABRIDAE		
25	Habitation	Coastal	4	KAL-10C-TU6-3-7	199927.2875	2223645.974	SCARIDAE	CALOTOMUS	
328	Ritual	Coastal	1	KAL-1-TU1-1-2	200076.1938	2223394.749	Unidentifiable		
22	Habitation	Coastal	4	KAL-23A-TU3-1-9	199882.1103	2223615.031	SCARIDAE	CALOTOMUS	
23	Habitation	Coastal	4	KAL-23A-TU3-1-9	199882.1103	2223615.031	SCARIDAE	CALOTOMUS	
26	Habitation	Coastal	4	KAL-23A-TU3-1-9	199882.1103	2223615.031	SCARIDAE	CALOTOMUS	
27	Habitation	Coastal	4	KAL-23A-TU3-1-9	199882.1103	2223615.031	SCARIDAE		
262	Habitation	Coastal	4	KAL-23A-TU3-2-1	199882.1103	2223615.031	Carangidae		
149	Habitation	Coastal	4	KAL-23A-TU3-3-2	199882.1103	2223615.031	Scaridae	Calotomus	
161	Habitation	Coastal	4	KAL-23A-TU3-3-2	199882.1103	2223615.031	Scaridae	Calotomus	
58	Habitation	Coastal	4	KAL-23B-TU2-3-2	199876.9362	2223623.918	SCARIDAE	CALOTOMUS	

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
153	Habitation	Coastal	4	KAL-23B-TU2-3-2	199876.9362	2223623.918	Scaridae	Calotomus	
274	Habitation	Coastal	2	KAL-30A-TU1-BAULK-1-3-1	199794.5746	2223668.961	Unidentifiable		
300	Habitation	Coastal	2	KAL-30A-TU1-BAULK-3-1	199794.5746	2223668.961	Scaridae		
301	Habitation	Coastal	2	KAL-30A-TU1-BAULK-3-1	199794.5746	2223668.961	Labridae		
302	Habitation	Coastal	2	KAL-30A-TU1-BAULK-3-1	199794.5746	2223668.961	Balistidae		
275	Habitation	Coastal	2	KAL-30A-TU1B-FEA2-1-2	199794.5746	2223668.961	Unidentifiable		
227	Ritual	Coastal	3	KAL-30B-SA-4	199804.1351	2223657.909	Labridae		
384	Ritual	Coastal	3	KAL-30B-TU2-2-11	199804.1351	2223657.909	Diodontidae		
385	Ritual	Coastal	3	KAL-30B-TU2-2-11	199804.1351	2223657.909	Diodontidae		
29	Ritual	Coastal	3	KAL-30B-TU2-2-8	199804.1351	2223657.909	TETRADONTIDAE		
67	Ritual	Coastal	3	KAL-30B-TU2-3-7	199804.1351	2223657.909	Scorphaenidae		
10	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	SCARIDAE	CALOTOMUS	
13	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	SCARIDAE		
69	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Balistidae		
70	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Balistidae		
71	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Diodontidae		
72	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Tetradontidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
112	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Scaridae		
129	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Lutjanidae		
130	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Lutjanidae		
131	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Lutjanidae		
226	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Labridae		
260	Ritual	Coastal	3	KAL-30B-TU2-4-5	199804.1351	2223657.909	Coryphaenidae		
284	Ritual	Coastal	3	KAL-30B-TU2-BAULK-2-6	199804.1351	2223657.909	Labridae		
285	Ritual	Coastal	3	KAL-30B-TU2-BAULK-2-6	199804.1351	2223657.909	Labridae		
286	Ritual	Coastal	3	KAL-30B-TU2-BAULK-2-6	199804.1351	2223657.909	Carangidae		
212	Habitation	Coastal	3	KAL-5A-TU1-3-14	199959.3858	2223776.6	Scaridae	Scarus	
296	Habitation	Coastal	3	KAL-5A-TU1-3-14	199959.3858	2223776.6	Diodontidae		
297	Habitation	Coastal	3	KAL-5A-TU1-3-14	199959.3858	2223776.6	Diodontidae		
298	Habitation	Coastal	3	KAL-5A-TU1-3-14	199959.3858	2223776.6	Diodontidae		
299	Habitation	Coastal	3	KAL-5A-TU1-3-14	199959.3858	2223776.6	Diodontidae		
5	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	SCARIDAE		
228	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
229	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
230	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
231	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
232	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
233	Habitation	Coastal	3	KAL-5A-TU1-4-3	199959.3858	2223776.6	Diodontidae		
126	Habitation	Coastal	3	KAL-5A-TU1-BAULK-1-1	199959.3858	2223776.6	Tetradontidae		
127	Habitation	Coastal	3	KAL-5A-TU1-	199959.3858	2223776.6	Carangidae		

				BAULK-1-1					
ID	**Function**	**Location**	**Period**	**Unit**	**Easting**	**Northing**	**Family**	**Genus**	**Species**
15	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	SCARIDAE	CALOTOMUS	
267	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	MONACANTHIDAE OR BALISTIDAE		
291	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	Lutjanidae		
292	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	Diodontidae		
293	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	Diodontidae		
294	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	Diodontidae		
295	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-1	199959.3858	2223776.6	Diodontidae		
17	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-7	199959.3858	2223776.6	SCARIDAE	CALOTOMUS	
42	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-7	199959.3858	2223776.6	LABRIDAE		
281	Habitation	Coastal	3	KAL-5A-TU1-BAULK-2-7	199959.3858	2223776.6	Labridae		
73	Habitation	Coastal	3	KAL-5A-TU1-BAULK-3-1	199959.3858	2223776.6	Tetradontidae		
44	Habitation	Coastal	3	KAL-5A-TU1-BAULK-3-8	199959.3858	2223776.6	LABRIDAE	THALASSOMA	DUPERREY
50	Habitation	Coastal	3	KAL-5A-TU1-BAULK-3-8	199959.3858	2223776.6	LABRIDAE	THALASSOMA	DUPERREY

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
256	Habitation	Coastal	3	KAL-5A-TU1-BAULK-3-8	199959.3858	2223776.6	Unidentifiable		
218	Habitation	Coastal	3	KAL-5A-TU1-EXT-3	199959.3858	2223776.6	Scaridae	Calotomus	
234	Habitation	Coastal	3	KAL-5A-TU1-EXT-3	199959.3858	2223776.6	Diodontidae		
235	Habitation	Coastal	3	KAL-5A-TU1-EXT-3	199959.3858	2223776.6	Diodontidae		
380	Habitation	Upland	2	KHL-2A-TU1-7-2	202491.86	223013.92	Diodontidae		
381	Habitation	Upland	2	KHL-2A-TU1-9-1	202491.86	223013.92	Balistidae		
11	Habitation	Upland	ND	KHL-2B-TU4-2-5	202425.76	2231969	SCARIDAE	CALOTOMUS	
68	Habitation	Upland	ND	KHL-2B-TU4-3-2	202425.76	2231969	Scaridae	Chlorurus	
75	Habitation	Upland	ND	KHL-2B-TU4-4-3	202425.76	2231969	Balistidae		
353	Habitation	Coastal	3	KHL-2D-TU2-3-6	202425.76	2231969	Scaridae		
9	Habitation	Upland	3	KHL-2D-TU2-FE1-NORTH-2	202425.76	2231969	SCARIDAE	CALOTOMUS	
18	Habitation	Upland	3	KHL-2H-TU3-3-2	202421.95	2231983.83	SCARIDAE	CALOTOMUS	
205	Habitation	Upland	3	KHL-2H-TU3-4-3	202421.95	2231983.83	Labridae	Thalassoma	duperrey
264	Habitation	Upland	3	KHL-2H-TU3-4-3	202421.95	2231983.83	Carangidae		
240	Habitation	Upland	3	KHL-2H-TU3-5-3	202421.95	2231983.83	Ostraciidae		
3	Habitation	Upland	3	KHL-2H-TU3-6-3	202421.95	2231983.83	Scaridae	CALOTOMUS	
74	Habitation	Coastal	2	MKE-104-TU1-F1-3-3	197916.96	2228326.89	Balistidae		
282	Habitation	Coastal	2	MKE-104-TU1-FE1-3-2	197916.96	2228326.89	Balistidae		
329	Habitation	Coastal	2	MKE-105-TU1-1-2	197910.49	2228299.97	Balistidae or Monacanthidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
271	Habitation	Coastal	1	MKE-106-TU1-1-3	197921.28	2228310.94	Unidentifiable		
247	Habitation	Coastal	1	MKE-106-TU1-2-5	197921.28	2228310.94	Labridae		
76	Habitation	Coastal	1	MKE-106-TU1-4-3	197921.28	2228310.94	Balistidae		
246	Habitation	Coastal	1	MKE-106-TU1-4-4	197921.28	2228310.94	MONACANTHIDAE OR BALISTIDAE		
363	Habitation	Coastal	ND	MKE-107-TU1-1-4	197842.24	2228223	Scaridae		
322	Habitation	Coastal	ND	MKE-107-TU1-2-1	197842.24	2228223	Scaridae		
332	Habitation	Coastal	ND	MKE-107-TU1-2-6	197842.24	2228223	Diodontidae		
19	Habitation	Coastal	3	MKE-108A-TU1-2-3	197794.99	2228289.15	SCARIDAE		
352	Habitation	Coastal	3	MKE-108A-TU1-2-3	197794.99	2228289.15	Monacanthidae		
12	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	SCARIDAE		
28	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	SCARIDAE		
354	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
355	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
356	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
357	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
358	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
359	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
360	Habitation	Coastal	3	MKE-108A-TU1-3-5	197794.99	2228289.15	Monacanthidae		
49	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	BALISTIDAE		
312	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
313	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
314	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
315	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
316	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
317	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
318	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
319	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
320	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Monacanthidae		
371	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Scaridae		
372	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Scaridae		
373	Habitation	Coastal	3	MKE-108A-TU1-3-6	197794.99	2228289.15	Scaridae		
325	Habitation	Coastal	3	MKE-108A-TU1-4-1	197794.99	2228289.15	Scaridae		
326	Habitation	Coastal	3	MKE-108A-TU1-4-1	197794.99	2228289.15	Monacanthidae		
340	Habitation	Coastal	3	MKE-108A-TU1-4-1	197794.99	2228289.15	Carangidae		
111	Habitation	Coastal	3	MKE-108A-TU1-4-2	197794.99	2228289.15	Monacanthidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
369	Habitation	Coastal	3	MKE-108A-TU1-4-2	197794.99	2228289.15	Monacanthidae		
370	Habitation	Coastal	3	MKE-108A-TU1-4-2	197794.99	2228289.15	Monacanthidae		
309	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
310	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
311	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
374	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
375	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
376	Habitation	Coastal	3	MKE-108A-TU1-4-6	197794.99	2228289.15	Monacanthidae		
361	Habitation	Coastal	ND	MKE-108B-TU2-2-3	197794.99	2228289.15	Monacanthidae		
362	Habitation	Coastal	ND	MKE-108B-TU2-2-3	197794.99	2228289.15	Monacanthidae		
47	Habitation	Coastal	ND	MKE-108B-TU2-3-1	197794.99	2228289.15	LABRIDAE		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
280	Habitation	Coastal	ND	MKE-108B-TU2-3-1	197794.99	2228289.15	Labridae		
204	Habitation	Coastal	ND	MKE-108B-TU2-3-4	197794.99	2228289.15	Labridae	Thalassoma	duperrey
321	Habitation	Coastal	ND	MKE-108B-TU2-3-4	197794.99	2228289.15	Balistidae		
20	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	SCARIDAE		
337	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	Carangidae		
364	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	Diodontidae		
365	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	Monacanthidae		
366	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	Monacanthidae		
367	Habitation	Coastal	ND	MKE-108B-TU2-4-6	197794.99	2228289.15	Scaridae		
77	Habitation	Coastal	3	MKI-11A-TU1-2-3	200354.1358	2222742.006	Balistidae		
223	Habitation	Coastal	3	MKI-11A-TU1-3-2	200354.1358	2222742.006	Scaridae	Calotomus	
78	Habitation	Coastal	3	MKI-11A-TU1-4-2	200354.1358	2222742.006	Balistidae		
79	Habitation	Coastal	3	MKI-11A-TU1-4-2	200354.1358	2222742.006	Scaridae	SCARUS	
4	Habitation	Coastal	3	MKI-11A-TU1-5-3	200354.1358	2222742.006	SCARIDAE	CHLORURUS	SPILURUS
65	Habitation	Coastal	3	MKI-1A-TU1-3-5	200462.5395	2222597.673	Scaridae		
64	Habitation	Coastal	3	MKI-1A-TU1-4-1	200462.5395	2222597.673	Scaridae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
186	Habitation	Coastal	3	MKI-1A-TU1-5-3	200462.5395	2222597.673	Carangidae		
187	Habitation	Coastal	3	MKI-1A-TU1-5-3	200462.5395	2222597.673	Carangidae		
115	Habitation	Coastal	3	MKI-1A-TU1-5-5	200462.5395	2222597.673	Acanthuridae		
116	Habitation	Coastal	3	MKI-1A-TU1-5-5	200462.5395	2222597.673	Belonidae		
184	Habitation	Coastal	3	MKI-1A-TU1-EXT-2-4	200462.5395	2222597.673	Balistidae		
185	Habitation	Coastal	3	MKI-1A-TU1-EXT-3-5	200462.5395	2222597.673	Balistidae		
209	Habitation	Coastal	3	MKI-1A-TU1-EXT-4	200462.5395	2222597.673	Labridae	Thalassoma	duperrey
210	Habitation	Coastal	3	MKI-1A-TU1-EXT-4	200462.5395	2222597.673	Labridae		
183	Habitation	Coastal	3	MKI-1A-TU1-EXT-5-3	200462.5395	2222597.673	Lutjanidae		
263	Habitation	Coastal	3	MKI-1A-TU1-EXT-6-2	200462.5395	2222597.673	Carangidae		
290	Habitation	Coastal	3	MKI-1A-TU1-EXT-6-2	200462.5395	2222597.673	Labridae		
117	Habitation	Coastal	3	MKI-1A-TU1-FE1-2	200462.5395	2222597.673	Scaridae	Scarus	
269	Habitation	Coastal	3	MKI-23A-TU1-2-1	200422.0111	2222915.187	Unidentifiable		
98	Habitation	Coastal	3	MKI-23A-TU1-4-2	200422.0111	2222915.187	Unidentified		
109	Habitation	Coastal	3	MKI-23A-TU1-5-4	200422.0111	2222915.187	Balistidae		
110	Habitation	Coastal	3	MKI-23A-TU1-5-4	200422.0111	2222915.187	Monacanthidae		
206	Habitation	Coastal	3	MKI-23A-TU1-5-4	200422.0111	2222915.187	Labridae	Thalassoma	duperrey

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
257	Habitation	Coastal	3	MKI-23A-TU1-5-4	200422.0111	2222915.187	Unidentifiable		
103	Habitation	Coastal	3	MKI-23A-TU1-6-2	200422.0111	2222915.187	Balistidae		
104	Habitation	Coastal	3	MKI-23A-TU1-6-2	200422.0111	2222915.187	Monacanthidae		
207	Habitation	Coastal	3	MKI-23A-TU1-6-2	200422.0111	2222915.187	Labridae	Thalassoma	duperrey
330	Habitation	Coastal	ND	MKI-23-TU2-1-7	200422.0111	2222915.187	Scaridae		
331	Habitation	Coastal	ND	MKI-23-TU2-1-7	200422.0111	2222915.187	Scaridae		
52	Habitation	Coastal	ND	MKI-24-TU1-3-4	200363	2222915	SCARIDAE	CALOTOMUS	
55	Habitation	Coastal	ND	MKI-25A-TU1-1-3	200320.2232	2223042.621	SCARIDAE		
208	Habitation	Coastal	ND	MKI-25A-TU1-1-3	200320.2232	2223042.621	Labridae	Thalassoma	duperrey
66	Habitation	Coastal	ND	MKI-25B-TU2-6-5	200324.5341	2223045.661	Scaridae		
336	Habitation	Coastal	3	MKI-25B-TU3-3-4	200324.5341	2223042.621	Diodontidae		
147	Habitation	Coastal	3	MKI-25B-TU3-5-2	200324.5341	2223042.621	Scaridae	Calotomus	
146	Habitation	Coastal	3	MKI-25B-TU3-6-5	200324.5341	2223042.621	Scaridae	Chlorurus	
266	Habitation	Coastal	3	MKI-25B-TU3-6-5	200324.5341	2223042.621	Mullidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
21	Habitation	Coastal	ND	MKI-25-TU2-2-3	200324.5341	2223042.621	SCARIDAE		
190	Habitation	Coastal	2	MKI-2A-TU1-2-2	200454.1163	2222746.767	Scaridae		
191	Habitation	Coastal	2	MKI-2A-TU1-2-2	200454.1163	2222746.767	Balistidae		
145	Habitation	Coastal	2	MKI-2A-TU1-4-2	200454.1163	2222746.767	Scaridae		
182	Habitation	Coastal	2	MKI-2A-TU1-4-2	200454.1163	2222746.767	Balistidae		
225	Habitation	Coastal	2	MKI-2A-TU1-4-2	200454.1163	2222746.767	Scaridae	Scarus	
118	Habitation	Coastal	2	MKI-2A-TU1-5-2	200454.1163	2222746.767	Belonidae		
57	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	SCARIDAE	CALOTOMUS	
152	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
154	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
155	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
156	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
157	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
158	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
159	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
160	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
163	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
168	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
169	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
170	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
171	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
172	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Chlorurus	
173	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
179	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Balistidae		
180	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Balistidae		
181	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Scaridae	Calotomus	
249	Habitation	Coastal	2	MKI-2A-TU2-1-4	200454.1163	2222746.767	Balistidae		
60	Habitation	Coastal	2	MKI-2A-TU2-2-8	200454.1163	2222746.767	SCARIDAE		
119	Habitation	Coastal	2	MKI-2A-TU2-2-8	200454.1163	2222746.767	Monacanthidae		
120	Habitation	Coastal	2	MKI-2A-TU2-2-8	200454.1163	2222746.767	Monacanthidae		
121	Habitation	Coastal	2	MKI-2A-TU2-2-8	200454.1163	2222746.767	Balistidae		
122	Habitation	Coastal	2	MKI-2A-TU2-2-8	200454.1163	2222746.767	Balistidae		
51	Habitation	Coastal	2	MKI-2A-TU2-3-5	200454.1163	2222746.767	SCARIDAE	CALOTOMUS	
125	Habitation	Coastal	2	MKI-2A-TU2-3-5	200454.1163	2222746.767	Balistidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
167	Habitation	Coastal	2	MKI-2A-TU2-3-5	200454.1163	2222746.767	Scaridae	Calotomus	
150	Habitation	Coastal	2	MKI-2A-TU2-5-4	200454.1163	2222746.767	Scaridae	Calotomus	
253	Habitation	Coastal	2	MKI-2A-TU2-FE1-2	200454.1163	2222746.767	Labridae		
254	Habitation	Coastal	2	MKI-2A-TU2-FE1-2	200454.1163	2222746.767	Labridae		
53	Habitation	Coastal	2	MKI-2A-TU2-SUR-4	200454.1163	2222746.767	SCARIDAE	CALOTOMUS	
164	Habitation	Coastal	2	MKI-2A-TU2-SUR-4	200454.1163	2222746.767	Scaridae	Calotomus	
165	Habitation	Coastal	2	MKI-2A-TU2-SUR-4	200454.1163	2222746.767	Scaridae	Calotomus	
252	Habitation	Coastal	2	MKI-2A-TU2-SUR-4	200454.1163	2222746.767	Labridae		
54	Habitation	Coastal	3	MKI-2C-TU3-3-2	200430.1568	2222730.796	SCARIDAE		
123	Habitation	Coastal	3	MKI-2C-TU3-3-2	200430.1568	2222730.796	Monacanthidae		
2	Habitation	Coastal	3	MKI-2C-TU3-3-7	200430.1568	2222730.796	Tetradontidae		
59	Habitation	Coastal	3	MKI-2C-TU3-5-3	200430.1568	2222730.796	SCARIDAE	CALOTOMUS	
194	Habitation	Coastal	3	MKI-2C-TU3-5-3	200430.1568	2222730.796	Balistidae		
195	Habitation	Coastal	3	MKI-2C-TU3-5-3	200430.1568	2222730.796	Labridae		
197	Habitation	Coastal	3	MKI-2C-TU3-5-3	200430.1568	2222730.796	Labridae	Thalassoma	duperrey
239	Habitation	Coastal	3	MKI-2C-TU3-5-3	200430.1568	2222730.796	Coryphaenidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
38	Habitation	Upland	3	MKI-300-TU1-2-1	206126.45	2229179.85	SCARIDAE	CALOTOMUS	
36	Habitation	Upland	2	MKI-300-TU1-3-3	206126.45	2229179.85	SCARIDAE	CALOTOMUS	
31	Habitation	Upland	3	MKI-301A-TU1-1-3	205665.9	2228881.7	SCARIDAE	CALOTOMUS	
80	Habitation	Upland	3	MKI-301A-TU1-1-3	205665.9	2228881.7	Scombridae		
219	Habitation	Upland	3	MKI-301A-TU1-1-3	205665.9	2228881.7	Scaridae	Chlorurus	
40	Habitation	Upland	3	MKI-301A-TU1-2-2	205665.9	2228881.7	LABRIDAE	OXYCHEILL NUS	UNIFASCI ATUS
81	Habitation	Upland	3	MKI-301A-TU1-2-2	205665.9	2228881.7	Scaridae		
217	Habitation	Upland	3	MKI-301A-TU1-2-2	205665.9	2228881.7	Scaridae	Scarus	
265	Habitation	Upland	3	MKI-301A-TU1-2-2	205665.9	2228881.7	Scaridae		
258	Habitation	Upland	3	MKI-301A-TU1-4-2	205665.9	2228881.7	Unidentifiable		
268	Habitation	Upland	1	MKI-303-TU1-2-2	205161.57	2228674.5	Unidentifiable		
43	Habitation	Upland	1	MKI-303-TU1-3-2	205161.57	2228674.5	LABRIDAE		
220	Habitation	Upland	1	MKI-303-TU1-3-2	205161.57	2228674.5	Scaridae	Scarus	
32	Habitation	Upland	1	MKI-303-TU1-4-2	205161.57	2228674.5	SCARIDAE		
201	Habitation	Upland	1	MKI-303-TU1-4-2	205161.57	2228674.5	Labridae	Thalassoma	duperrey
193	Habitation	Upland	3	MKI-304A-TU1-3-3	205045.9	2228750	Pomacentridae		
261	Habitation	Upland	3	MKI-304A-TU1-3-3	205045.9	2228750	Carangidae		
273	Habitation	Upland	3	MKI-304A-TU1-4-2	205045.9	2228750	Unidentifiable		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
30	Habitation	Upland	3	MKI-304A-TU1-FE1-2	205045.9	2228750	SCARIDAE		
82	Habitation	Upland	3	MKI-304A-TU1-FE2-2	205045.9	2228750	Mullidae		
85	Habitation	Upland	3	MKI-306-TU1-1-3	204604	2228040	Lutjanidae		
124	Habitation	Upland	3	MKI-306-TU1-2-3	204604	2228040	Balistidae		
216	Habitation	Upland	3	MKI-306-TU1-2-3	204604	2228040	Scaridae	Scarus	
192	Habitation	Upland	3	MKI-306-TU1-3-3	204604	2228040	Balistidae		
178	Habitation	Upland	3	MKI-306-TU1-FE2-3-3	204604	2228040	Balistidae		
37	Habitation	Upland	2	MKI-378A-TU1-4-3	205470	2228870	SCARIDAE	CALOTOMUS	
35	Habitation	Upland	2	MKI-378A-TU1-5-35	205470	2228870	SCARIDAE	CALOTOMUS	
83	Habitation	Upland	2	MKI-378A-TU1-5-35	205470	2228870	Scaridae	Calotomus	
84	Habitation	Upland	2	MKI-378A-TU1-5-35	205470	2228870	Labridae	Anampses	cuvier
39	Habitation	Upland	2	MKI-378A-TU1-5-4	205470	2228870	SCARIDAE	CALOTOMUS	
33	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	SCARIDAE		
34	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	SCARIDAE	CALOTOMUS	
128	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	Kyphosidae		
215	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	Scaridae	Scarus	
221	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	Scaridae	Calotomus	
222	Habitation	Upland	ND	MKI-378B-TU2-2-4	205470	2228870	Scaridae	Scarus	
86	Habitation	Upland	ND	MKI-378C-TU3-3-2	205470	2228870	Pomacentridae		
87	Habitation	Upland	ND	MKI-378C-TU3-3-2	205470	2228870	Balistidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
175	Habitation	Coastal	3	MKI-414-TU1-1-3	201410.51	2224445.8	Balistidae		
176	Habitation	Coastal	3	MKI-414-TU1-1-3	201410.51	2224445.8	Balistidae		
177	Habitation	Coastal	3	MKI-414-TU1-1-3	201410.51	2224445.8	Balistidae		
203	Habitation	Coastal	3	MKI-414-TU1-1-3	201410.51	2224445.8	Labridae	Thalassoma	duperrey
283	Habitation	Coastal	3	MKI-414-TU1-1-3	201410.51	2224445.8	Scaridae		
88	Habitation	Coastal	3	MKI-414-TU1-2-2	201410.51	2224445.8	Balistidae		
89	Habitation	Coastal	3	MKI-414-TU1-2-2	201410.51	2224445.8	Scombridae		
90	Habitation	Coastal	3	MKI-414-TU1-2-2	201410.51	2224445.8	Labridae		
91	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Scaridae		
92	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Labridae		
144	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Acanthuridae		
244	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Monacanthidae		
270	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Unidentifiable		
378	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Monacanthidae		
379	Habitation	Coastal	3	MKI-56-SA-11	200175.8287	2223336.484	Monacanthidae		
151	Habitation	Coastal	3	MKI-56-SA-3	200175.8287	2223336.484	Scaridae	Calotomus	
188	Habitation	Coastal	3	MKI-56-SA-3	200175.8287	2223336.484	Monacanthidae		
189	Habitation	Coastal	3	MKI-56-SA-3	200175.8287	2223336.484	Carangidae		
224	Habitation	Coastal	3	MKI-56-SA-3	200175.8287	2223336.484	Scaridae	Scarus	

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
304	Habitation	Coastal	3	MKI-56-SA-3	200175.8287	2223336.484	Carangidae		
93	Habitation	Coastal	3	MKI-56-TU1-2-4	200175.8287	2223336.484	Scaridae		
307	Habitation	Coastal	3	MKI-56-TU1-3-10	200175.8287	2223336.484	Labridae		
45	Habitation	Coastal	3	MKI-56-TU1-3-11	200175.8287	2223336.484	BALISTIDAE		
94	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Scaridae	Scarus	
95	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Monacanthidae		
96	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Monacanthidae		
174	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Scaridae		
255	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Mullidae		
259	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	PRIACANTHID AE		
289	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Labridae		
303	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Carangidae		
306	Habitation	Coastal	3	MKI-56-TU1-3-3	200175.8287	2223336.484	Labridae		
143	Habitation	Coastal	3	MKI-56-TU1-4-2	200175.8287	2223336.484	Balistidae		
114	Habitation	Coastal	3	MKI-56-TU1-4-9	200175.8287	2223336.484	Balistidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
241	Habitation	Coastal	3	MKI-56-TU1-4-9	200175.8287	2223336.484	Labridae		
242	Habitation	Coastal	3	MKI-56-TU1-4-9	200175.8287	2223336.484	Diodontidae		
243	Habitation	Coastal	3	MKI-56-TU1-4-9	200175.8287	2223336.484	Diodontidae		
62	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Scaridae		
63	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Scaridae		
133	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Diodontidae		
134	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Monacanthidae		
135	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Balistidae		
136	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Scaridae	Calotomus	
288	Habitation	Coastal	3	MKI-56-TU1-5-1	200175.8287	2223336.484	Carangidae		
113	Habitation	Coastal	3	MKI-56-TU1-5-11	200175.8287	2223336.484	Balistidae		
97	Habitation	Coastal	3	MKI-56-TU1-6-11	200175.8287	2223336.484	Labridae		
137	Habitation	Coastal	3	MKI-56-TU1-6-2	200175.8287	2223336.484	Monacanthidae		
138	Habitation	Coastal	3	MKI-56-TU1-6-2	200175.8287	2223336.484	Labridae		
139	Habitation	Coastal	3	MKI-56-TU1-6-2	200175.8287	2223336.484	Labridae		
132	Habitation	Coastal	3	MKI-56-TU1-7-2	200175.8287	2223336.484	Coryphaenidae		
162	Habitation	Coastal	3	MKI-56-TU1-7-2	200175.8287	2223336.484	Scaridae	Scarus	
6	Habitation	Coastal	3	MKI-56-TU1-8-10	200175.8287	2223336.484	SCARIDAE		
199	Habitation	Coastal	3	MKI-56-TU1-8-10	200175.8287	2223336.484	Labridae	Thalassoma	duperrey
202	Habitation	Coastal	3	MKI-56-TU1-8-10	200175.8287	2223336.484	Labridae	Thalassoma	duperrey
1	Habitation	Coastal	3	MKI-56-TU1-8-2	200175.8287	2223336.484	Scaridae	SCARUS	DUBIUS

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
140	Habitation	Coastal	3	MKI-56-TU1-8-2	200175.8287	2223336.484	Balistidae		
141	Habitation	Coastal	3	MKI-56-TU1-8-9	200175.8287	2223336.484	Acanthuridae		
142	Habitation	Coastal	3	MKI-56-TU1-8-9	200175.8287	2223336.484	Acanthuridae		
245	Habitation	Coastal	3	MKI-56-TU1-8-9	200175.8287	2223336.484	Monacanthidae		
41	Habitation	Coastal	1	PHH-13A-TU1-2-10	200685.085	2222362.1	LABRIDAE		
323	Habitation	Coastal	1	PHH-13A-TU1-2-10	200685.085	2222362.1	Monacanthidae		
324	Habitation	Coastal	1	PHH-13A-TU1-2-10	200685.085	2222362.1	Monacanthidae		
338	Habitation	Coastal	1	PHH-13A-TU1-2-10	200685.085	2222362.1	Lutjanidae		
343	Habitation	Coastal	1	PHH-13A-TU1-2-10	200685.085	2222362.1	Holocentridae		
368	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Labridae		
386	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Balistidae		
387	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Monacanthidae		
388	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Diodontidae		
389	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Carangidae		
390	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Unidentifiable		
391	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Acanthuridae		
392	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Labridae		
393	Habitation	Coastal	1	PHH-13A-TU1-3-17	200685.085	2222362.1	Balistidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
345	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Balistidae		
346	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Balistidae		
382	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Labridae	Thalassoma	
383	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Labridae	Thalassoma	
395	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Unidentifiable		
396	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Balistidae		
397	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Labridae	Thalassoma	
398	Habitation	Coastal	1	PHH-13A-TU1-3-18	200685.085	2222362.1	Labridae		
394	Habitation	Coastal	1	PHH-13A-TU1-3-4	200685.085	2222362.1	Balistidae		
16	Habitation	Coastal	1	PHH-13A-TU1-3-8	200685.085	2222362.1	SCARIDAE		
339	Habitation	Coastal	1	PHH-13A-TU1-4-11	200685.085	2222362.1	Carangidae		
344	Habitation	Coastal	1	PHH-13A-TU1-4-2	200685.085	2222362.1	Serranidae		
342	Habitation	Coastal	1	PHH-13-TU1-2-10	200685.085	2222362.1	Unidentifiable		
351	Habitation	Coastal	1	PHH-13-TU1-2-11	200685.085	2222362.1	Scaridae		
198	Habitation	Coastal	1	PHH-13-TU1-2-3	200685.085	2222362.1	Labridae	Thalassoma	duperrey
334	Habitation	Coastal	1	PHH-13-TU1-2-3	200685.085	2222362.1	Diodontidae		
349	Habitation	Coastal	1	PHH-13-TU1-2-3	200685.085	2222362.1	Monacanthidae		

ID	Function	Location	Period	Unit	Easting	Northing	Family	Genus	Species
350	Habitation	Coastal	1	PHH-13-TU1-2-3	200685.085	2222362.1	Monacanthidae		
14	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	SCARIDAE		
46	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	LABRIDAE		
200	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Labridae	Thalassoma	duperrey
213	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Scaridae	Chlorurus	
214	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Scaridae		
335	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Diodontidae		
341	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Acanthuridae		
347	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Tetradontidae		
348	Habitation	Coastal	1	PHH-13-TU1-3-4	200685.085	2222362.1	Tetradontidae		
333	Habitation	Coastal	1	PHH-13-TU1-SUR-2	200685.085	2222362.1	Diodontidae		
48	Habitation	Coastal	1	PHH-30-TU1-1-5	200787.5	2222589.61	LABRIDAE		
8	Habitation	Coastal	1	PHH-30-TU1-2-6	200787.5	2222589.61	SCARIDAE	CALOTOMUS	
327	Habitation	Coastal	1	PHH-30-TU1-3-4	200787.5	2222589.61	Scaridae		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
61	Inshore Zone	Upper Pharyngeal	L	10.72	No		4.08	Yes		
250	Inshore Zone	Tooth	UK		No			No		
251	Inshore Zone	1st Dorsal Spine	NA		No			No		V. SMALL FRAG

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
105	Inshore Zone	1st Dorsal Spine	NA	3.56	No		2.08	No		
287	Inshore Zone	Premaxilla	R	2.17	No	9.68		No		
276	Inshore Zone	1st Dorsal Spine	NA		No			No		V. SMALL FRAG-DIDN'T MEASURE
277	Inshore Zone	Tooth	UK		No			No		
101	Inshore Zone	Tooth	UK		No			No		
102	Inshore Zone	Tooth			No			No		
56	Inshore Zone	LPH	NA	5.22	No		3.69	No		
107	Inshore Zone	Dentary	L	5.77	No		3.91	Yes		
166	Inshore Zone	Dentary	L	18.45	Yes		8.19	No		
248	Other	Dentary	R	8.06	No		3.61	Yes		
272		Quadrate	UK		No			No		
148	Inshore Zone	Premaxilla or Dentary	UK	4.40	No		4.25	No		
108	Inshore Zone	Premaxilla or Dentary	UK	4.31	No		5.22	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
278	Inshore Zone	Premaxilla	UK	11.93	No		4.41	No		
238	Inshore Zone	Dentary	R	15.85	No	5.16		No		
106	Inshore Zone	Spines	UK	8.51	No		9.71	No		
196	Inshore Zone	Lower Pharyngeal	NA	5.90	No	11.80	3.23	No		
100	Inshore Zone	Premaxilla or Dentary	UK	6.29	No		5.22	No		
211	Inshore Zone	Lower Pharyngeal	NA	8.16	Yes		4.94	No		
279	Inshore Zone	Tooth	UK		No			No		TOOTH FROM LOWER PHARYNGEAL-DIDN'T MEASURE
99	Inshore Zone	1st Dorsal Spine	NA	12.46	No		3.62	No		
236	Inshore Zone	Lower Pharyngeal	NA	5.92	No		2.46	No		BURNED
237	Inshore Zone	Lower Pharyngeal	NA	2.83	No		3.76	No		
7	Inshore Zone	TOOTH	NA	2.14	Yes		1.27	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
24	Inshore Zone	TOOTH	NA	1.62	Yes		2.69	Yes		
25	Inshore Zone	TOOTH	NA	1.57	Yes		3.13	Yes		
328		Premaxilla or Dentary			No			No		
22	Inshore Zone	TOOTH	NA	1.97	Yes		2.96	Yes		
23	Inshore Zone	TOOTH	NA	1.78	Yes		2.01	Yes		
26	Inshore Zone	D OR PM	UK	2.69	No		3.98	No		
27	Inshore Zone	UPH/LPH	UK	3.30	No		2.35	No		
262	Pelagic Zone	Quadrate	R	5.80	No		6.77	Yes		
149	Inshore Zone	Premaxilla or Dentary	UK	3.54	No		3.43	No		
161	Inshore Zone	Premaxilla or Dentary	UK	2.74	No		5.17	No		
58	Inshore Zone	D	R	6.61	No		5.62	No		
153	Inshore Zone	Premaxilla or Dentary	UK	4.32	No		6.60	No		
274		Quadrate	UK		No			No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
300	Inshore Zone	Tooth	UK		No			No		
301	Inshore Zone	Lower Pharyngeal	NA	5.00	No		2.57	No		
302	Inshore Zone	Scale	UK		No			No		
275		Quadrate	UK		No			No		
227	Inshore Zone	Upper Pharyngeal	L	15.80	Yes		13.47	Yes		
384		Tooth	UK		No			No		NOT SAME FISH AS #382
385		Tooth	UK		No			No		NOT SAME FISH AS #381
29	Inshore Zone	D	R	14.47	No		21.01	Yes		
67	Inshore Zone	Dentary	L	61.09	Yes		10.18	Yes		
10	Inshore Zone	UPH	R	8.60	No		5.69	Yes		
13	Inshore Zone	LPH	NA	5.40	No		6.00	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
69	Inshore Zone	1st Dorsal Spine	NA	14.91	No		7.91	Yes		
70	Inshore Zone	Pterygial Carina	NA	20.31	No		11.00	No		
71	Inshore Zone	Spines	UK	24.72	Yes		14.68	No		
72	Inshore Zone	Dentary	R	17.31	Yes		16.43	Yes		
112	Inshore Zone	Premaxilla	L	3.02	No		8.09	No		
129	Other	Dentary	L	40.79	No		13.24	Yes		
130	Other	Premaxilla	L	22.47	No		13.44	Yes		
131	Other	Angular	L	23.59	Yes		11.37	Yes		
226	Inshore Zone	Upper Pharyngeal	L	7.09	Yes		5.90	Yes		
260		Quadrate	R	20.61	No		9.96	No		
284	Inshore Zone	Premaxilla	R	4.81	No		6.86	No		
285	Inshore Zone	Lower Pharyngeal	NA	4.63	No		1.80	No		
286	Pelagic Zone	Dentary	L	3.81	No		3.06	No		
212	Inshore Zone	Premaxilla	R	10.16	No		22.99	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
296	Inshore Zone	Spines	UK	18.66	Yes		9.81	No		
297	Inshore Zone	Spines	UK	26.64	Yes		8.41	No		
298	Inshore Zone	Spines	UK	23.14	No		20.27	No		
299	Inshore Zone	Spines	UK	10.11	No		11.19	No		
5	Inshore Zone	UPH	R	17.34	No		4.02	Yes		
228	Inshore Zone	Spines	NA	23.78	Yes		19.90	No		
229	Inshore Zone	Spines	NA	10.59	No		15.68	No		
230	Inshore Zone	Spines	NA	33.84	No		18.72	Yes		
231	Inshore Zone	Spines	NA	13.36	No		19.31	No		
232	Inshore Zone	Spines	NA	20.90	No		24.79	No		
233	Inshore Zone	Spines	NA	15.87	No		12.59	No		
126	Inshore Zone	Dentary	L	17.02	No		11.30	No		
127	Pelagic Zone	Premaxilla or Dentary	UK	14.05	No		2.69	No		
15	Inshore Zone	D	R	5.05	No		9.62	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
267	Inshore Zone	1st Dorsal Spine	NA		No			No		SMALL FRAG-DIDN'T MEASURE
291	Other	Dentary	R	11.87	No		3.36	No		
292	Inshore Zone	Spines	UK	25.26	No		17.74	No		
293	Inshore Zone	Spines	UK	31.68	No		9.97	No		
294	Inshore Zone	Spines	UK	12.48	No		8.08	No		
295	Inshore Zone	Spines	UK	18.90	No		11.82	No		
17	Inshore Zone	D OR PM	UK	6.42	No		2.59	No		
42	Inshore Zone	LPH	NA	3.33	No		1.52	No		
281	Inshore Zone	Premaxilla or Dentary	UK		No			No		V. SMALL FRAG
73	Inshore Zone	Dentary	R	13.56	No		18.55	Yes		
44	Inshore Zone	PM	L	3.00	No		4.95	No		
50	Inshore Zone	LPH	NA	0.5	No		1.95	No		
256		Angular	R		No			No		
218	Inshore Zone	Lower Pharyngeal	NA	28.62	Yes		10.42	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
234	Inshore Zone	Spines	NA	26.81	Yes		35.69	Yes		
235	Inshore Zone	Spines	NA	48.93	Yes		43.90	No		
380		Spines	UK	23.79	No		21.68	No		
381		Pelvis	NA	40.08	No		3.73	Yes		
11	Inshore Zone	D OR PM	UK	13.35	No		9.02	No		
68	Inshore Zone	Premaxilla	R	12.25	No		10.95	No		
75	Inshore Zone	1st Dorsal Spine	NA	9.45	No		3.15	No		
353	Inshore Zone	Lower Pharyngeal	NA	11.57	Yes		8.35	Yes		
9	Inshore Zone	UPH	UK	10.65	No		7.95	No		
18	Inshore Zone	PM	R	10.65	No		6.78	No		
205	Inshore Zone	Lower Pharyngeal	NA	10.21	Yes		4.60	No		
264	Pelagic Zone	Quadrate	L	7.71	Yes		3.50	No		
240	Inshore Zone	Scale	UK		No			No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
3	Inshore Zone	Dentary	L	18.57	No		16.29	Yes		
74	Inshore Zone	1st Dorsal Spine	NA	13.14	No		3.94	Yes		
282	Inshore Zone	1st Dorsal Spine	NA	5.96	No		1.64	No		
329	Inshore Zone	1st Dorsal Spine	NA		No			No		
271		Quadrate	R		No			No		
247	Inshore Zone	Premaxilla	L	3.62	No		11.67	Yes		
76	Inshore Zone	1st Dorsal Spine	NA	5.70	No		3.59	Yes		
246	Inshore Zone	1st Dorsal Spine	NA	7.19	No		1.27	No		
363	Inshore Zone	Premaxilla or Dentary	UK	9.17	No		6.53	No		
322	Inshore Zone	Upper Pharyngeal	UK		No		3.37	No		very fragmented-couldn't measure length
332	Inshore Zone	Tooth	UK		No			No		HALF OF THE TOOTH PLATE

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
19	Inshore Zone	D OR PM	UK	7.73	No		7.93	No		
352	Inshore Zone	1st Dorsal Spine	NA	10.39	No		3.32	Yes		
12	Inshore Zone	LPH	NA	3.61	No		5.49	No		
28	Inshore Zone	LPH	NA	4.86	No		5.43	No		
354	Inshore Zone	1st Dorsal Spine	NA	14.46	No		3.48	Yes		
355	Inshore Zone	1st Dorsal Spine	NA	17.24	No		4.39	Yes		
356	Inshore Zone	1st Dorsal Spine	NA	15.14	No		3.01	No		
357	Inshore Zone	1st Dorsal Spine	NA	10.61	No		2.64	No		
358	Inshore Zone	1st Dorsal Spine	NA	8.48	No		2.65	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
359	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
360	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
49	Inshore Zone	SCALE	UK	2.85	No		1.71	No		
312	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
313	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
314	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
315	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
316	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
317	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
318	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
319	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
320	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
371	Inshore Zone	Tooth	UK		No			No		
372	Inshore Zone	Tooth	UK		No			No		
373	Inshore Zone	Tooth	UK		No			No		
325	Inshore Zone	Lower Pharyngeal	NA	6.10	No		5.83	No		
326	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
340	Pelagic Zone	Quadrate	R	4.99	No		6.46	No		
111	Inshore Zone	Dorsal Spine or Pelvis	na		No			No		DIDN'T MEASURE-LOTS OF FRAGMENTS
369	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
370	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
309	Inshore Zone	1st Dorsal Spine	NA	15.60	No		2.60	No		
310	Inshore Zone	1st Dorsal Spine	NA	12.44	No	2.72		No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
311	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
374	Inshore Zone	1st Dorsal Spine	NA	20.56	No		3.88	Yes		
375	Inshore Zone	1st Dorsal Spine	NA	13.6	No		3.90	Yes		
376	Inshore Zone	1st Dorsal Spine	NA	12.15	No		3.78	Yes		
361	Inshore Zone	1st Dorsal Spine	NA	20.04	No		3.08	Yes		
362	Inshore Zone	1st Dorsal Spine	NA	17.02	No		3.90	Yes		
47	Inshore Zone	LPH	NA	3.24	No		1.73	No		
280	Inshore Zone	Premaxilla or Dentary	UK		No			No		V. SMALL FRAG
204	Inshore Zone	Lower Pharyngeal	NA	9.05	Yes		4.65	No		
321	Inshore Zone	Premaxilla	L	12.29	Yes		11.32	No		
20	Inshore Zone	UPH	L	12.30	No		3.16	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
337	Pelagic Zone	Dentary	UK	23.70	No		6.16	No		
364	Inshore Zone	Spines	UK		No			No		
365	Inshore Zone	1st Dorsal Spine	NA	15.80	No		2.87	Yes		
366	Inshore Zone	1st Dorsal Spine	NA	21.57	No		3.27	Yes		
367	Inshore Zone	Dentary	R	11.17	Yes		6.88	Yes		
77	Inshore Zone	1st Dorsal Spine	NA	13.85	No		3.72	No		BURNED
223	Inshore Zone	Lower Pharyngeal	NA	24.93	No	30.10	11.37	No		
78	Inshore Zone	Pterygial Carina	NA	5.50	No		6.12	No		
79	Inshore Zone	Premaxilla	R	5.44	No		8.40	No		
4	Inshore Zone	D	L	7.10	No		6.73	Yes		
65	Inshore Zone	Upper Pharyngeal	L	7.62	No		2.65	Yes		
64	Inshore Zone	Upper Pharyngeal	L	11.93	No	2.95	2.95	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
186	Pelagic Zone	Quadrate	L	11.27	No		6.01	No		
187	Pelagic Zone	Angular	L	18.80	Yes		10.62	Yes		
115	Inshore Zone	Maxilla	L	6.44	Yes		2.75	Yes		
116	Other	Premaxilla or Dentary	UK	6.27	No		1.07	No		
184	Inshore Zone	1st Dorsal Spine	NA	18.77	No		7.95	Yes		
185	Inshore Zone	1st Dorsal Spine	NA	10.19	No		3.49	No		
209	Inshore Zone	Lower Pharyngeal	NA	12.04	Yes		8.04	Yes		
210	Inshore Zone	Dentary	R	8.18	Yes		4.55	Yes		
183	Other	Dentary	R	19.67	Yes		5.63	Yes		
263	Pelagic Zone	Quadrate	R	6.90	Yes		6.29	Yes		
290	Inshore Zone	Premaxilla	R	3.51	No		13.16	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
117	Inshore Zone	Dentary	R	5.87	No		5.28	No		
269		Quadrate	UK		No			No		
98		Angular	R	8.99	No		7.05	Yes		DON'T HAVE IDENTIFICATION FOR-IS IN TBI PILE
109	Inshore Zone	1st Dorsal Spine	NA	17.63	No		6.12	Yes		
110	Inshore Zone	Dorsal Spine	NA		No			No		DIDN'T MEASURE-HIGHLY FRAGMENTED
206	Inshore Zone	Premaxilla	R	3.68	Yes		6.43	Yes		
257		Angular	L		No			No		
103	Inshore Zone	1st Dorsal Spine	NA	13.14	No		6.69	Yes		
104	Inshore Zone	Dorsal Spine	NA	7.70	No		1.50	No		
207	Inshore Zone	Premaxilla	R	6.17	No		17.95	Yes		
330	Inshore Zone	Upper Pharyngeal	L	10.77	No		4.87	No		NOT SAME FISH AS ENTRY #331
331	Inshore Zone	Upper Pharyngeal	R	8.39	No		7.24	No		NOT SAME FISH AS ENTRY #330
52	Inshore Zone	UPH	UK	5.01	No		4.65	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
55	Inshore Zone	LPH	NA	2.70	No		3.68	No		
208	Inshore Zone	Lower Pharyngeal	NA	8.81	Yes		4.24	No		
66	Inshore Zone	Upper Pharyngeal	R	10.12	No		3.60	Yes		
336	Inshore Zone	Tooth			No			No		HALF OF TOOTH
147	Inshore Zone	Upper Pharyngeal	UK	6.17	No		1.64	No		
146	Inshore Zone	Premaxilla	R	10.42	No		7.32	No		
266	Inshore Zone	Quadrate	L	8.31	No		6.65	No		
21	Inshore Zone	TOOTH	NA	3.31	Yes		2.00	Yes		
190	Inshore Zone	Premaxilla or Dentary	UK	6.60	No		4.31	No		
191	Inshore Zone	1st Dorsal Spine	NA	10.34	No		2.12	No		
145	Inshore Zone	Upper Pharyngeal	L	5.12	No		3.51	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
182	Inshore Zone	1st Dorsal Spine	NA	25.73	No		9.59	Yes		
225	Inshore Zone	Lower Pharyngeal	NA	11.69	No	18.0	13.19	No		
118	Other	Dentary	L	6.48	No		1.33	No		
57	Inshore Zone	Upper Pharyngeal	UK	5.18	No		5.83	No		
152	Inshore Zone	Upper Pharyngeal	R	7.82	No		7.62	Yes		
154	Inshore Zone	Upper Pharyngeal	UK	4.52	No		3.82	No		
155	Inshore Zone	Lower Pharyngeal	NA	5.14	No		6.38	No		
156	Inshore Zone	Pharyngeal	UK	4.55	No		6.36	No		
157	Inshore Zone	Premaxilla or Dentary	UK	7.99	No		7.69	No		BURNED
158	Inshore Zone	Upper Pharyngeal	R	8.37	No		7.67	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
159	Inshore Zone	Premaxilla	R	12.66	No		4.88	No		
160	Inshore Zone	Premaxilla or Dentary	UK	12.95	No		6.96	No		BURNED
163	Inshore Zone	Lower Pharyngeal	NA	5.47	No		6.56	No		
168	Inshore Zone	Lower Pharyngeal	NA	6.59	No		4.97	No		
169	Inshore Zone	Lower Pharyngeal	NA	6.32	No		6.13	No		
170	Inshore Zone	Lower Pharyngeal	NA	6.80	No		7.85	No		
171	Inshore Zone	Lower Pharyngeal	NA	4.53	No		6.61	No		
172	Inshore Zone	Premaxilla	R	7.70	No		5.28	No		
173	Inshore Zone	Premaxilla or Dentary	UK	6.66	No		8.73	No		
179	Inshore Zone	1st Dorsal Spine	NA	18.72	No		6.58	No	8.20	

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
180	Inshore Zone	1st Dorsal Spine	NA	11.92	No		3.48	No		
181	Inshore Zone	Pharyngeal	UK		No			No		UNMEASURABLE
249	Inshore Zone	1st Dorsal Spine	NA	15.36	No		4.41	No		
60	Inshore Zone	UPH	R	9.65	No		3.65	Yes		
119	Inshore Zone	Dorsal Spine	NA	13.02	No		2.39	Yes		
120	Inshore Zone	Dorsal Spine	NA	4.15	No		1.68	No		NOT SAME SPINE AS ID#119
121	Inshore Zone	Scale	UK		No			No		
122	Inshore Zone	Scale	UK		No			No		
51	Inshore Zone	Pharyngeal	R	12.22	No		10.36	No		
125	Inshore Zone	1st Dorsal Spine	NA	11.27	No		2.18	No		
167	Inshore Zone	Lower Pharyngeal	NA	5.23	No		8.83	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
150	Inshore Zone	Upper Pharyngeal	R	10.42	No		6.04	Yes		
253	Inshore Zone	Premaxilla	L	13.57	No		3.12	No		DIF. FISH THAN RECORD #254 (SIZE MATCHING)
254	Inshore Zone	Premaxilla	R	9.44	No		1.99	No		
53	Inshore Zone	Upper Pharyngeal	L	5.97	No		7.85	Yes		
164	Inshore Zone	Premaxilla or Dentary	UK	6.77	No		3.89	No		
165	Inshore Zone	Upper Pharyngeal	UK	4.59	No		3.84	No		
252	Inshore Zone	Lower Pharyngeal	NA		No			No		HIGHLY FRAGMENTED-DIDN'T MEASURE
54	Inshore Zone	UPH	L	9.22	No		3.37	Yes		
123	Inshore Zone	Dorsal Spine	NA	19.19	No		1.89	No		
2	Inshore Zone	Dentary	R	10.79	No		12.68	Yes		BURNED-POSSIBLY MODIFIED-WAS MISIDENTIFIED IN REPORT AS SCARIDAE

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
59	Inshore Zone	LPH	NA	10.15	No		6.46	No		
194	Inshore Zone	1st Dorsal Spine	NA	10.35	No		3.24	Yes		
195	Inshore Zone	Lower Pharyngeal	NA	14.78	No		6.87	No		
197	Inshore Zone	Lower Pharyngeal	NA	7.90	No	12.40	4.44	No		
239		Quadrate	R	21.79	Yes		20.67	Yes		
38	Inshore Zone	UPH	R	18.04	No		9.34	Yes		
36	Inshore Zone	UPH	L	22.76	No	23.00	9.70	Yes		
31	Inshore Zone	D	R	17.17	No		12.04	No		
80	Pelagic Zone	Maxilla	L	14.45	No		5.33	Yes		
219	Inshore Zone	Dentary	R	8.62	No		6.28	Yes		
40	Inshore Zone	D	L	13.26	No		11.22	Yes		
81	Inshore Zone	Pharyngeal	UK		No			No		COULDN'T MEASURE

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
217	Inshore Zone	Lower Pharyngeal	NA	11.27	No	16.0	13.69	Yes		
265	Inshore Zone	Quadrate	L	7.91	No	11.16		No		
258		Angular	R		No			No		
268		Quadrate	UK		No			No		
43	Inshore Zone	LPH	NA	3.85	No		3.66	No		
220	Inshore Zone	Dentary	L	11.66	Yes		6.31	Yes		
32	Inshore Zone	UPH	L	7.67	No		2.82	Yes		
201	Inshore Zone	Lower Pharyngeal	NA	12.06	Yes		7.50	Yes		
193	Inshore Zone	Angular	R	7.09	Yes		8.77	Yes		
261	Pelagic Zone	Quadrate	L	10.41	Yes		6.84	Yes		
273		Quadrate	R		No			No		
30	Inshore Zone	LPH	NA	9.02	No		6.21	No		
82	Inshore Zone	Quadrate	L	13.16	Yes		9.19	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
85	Other	Premaxilla	R	22.07	Yes		9.25	No		
124	Inshore Zone	2nd Dorsal Spine	NA	17.84	No		13.10	No		
216	Inshore Zone	Lower Pharyngeal	NA	10.19	Yes		7.41	Yes		
192	Inshore Zone	1st Dorsal Spine	NA	21.71	Yes		6.10	Yes		
178	Inshore Zone	2nd Dorsal Spine	NA	9.77	No	2.84		No		
37	Inshore Zone	UPH	R	25.02	No		11.19	Yes		
35	Inshore Zone	D	R	17.01	No		8.48	No		
83	Inshore Zone	Upper Pharyngeal	R	10.32	No		7.50	Yes		
84	Inshore Zone	Premaxilla	L	6.82	Yes		13.02	Yes		
39	Inshore Zone	D	L	13.33	No		9.41	No		
33	Inshore Zone	UPH	L	6.95	No		1.77	Yes		
34	Inshore Zone	PM	R	6.78	No		13.74	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
128	Inshore Zone	Quadrate	R	6.58	No		8.51	No		
215	Inshore Zone	Lower Pharyngeal	NA	21.31	Yes		16.14	Yes		
221	Inshore Zone	Lower Pharyngeal	NA	11.58	No		6.02	No		
222	Inshore Zone	Dentary	L	10.20	Yes		6.20	Yes		
86	Inshore Zone	Maxilla	L	8.66	No		4.18	Yes		
87	Inshore Zone	1st Dorsal Spine	NA	38.41	Yes		13.17	Yes		
175	Inshore Zone	1st Dorsal Spine	NA	12.56	No		6.50	Yes		SLIGHTLY BURNED
176	Inshore Zone	1st Dorsal Spine	NA	8.82	Yes		6.61	Yes		
177	Inshore Zone	1st Dorsal Spine	NA	12.18	No		2.76	No		
203	Inshore Zone	Lower Pharyngeal	NA	12.70	Yes		4.33	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
283	Inshore Zone	Tooth	UK		No			No		
88	Inshore Zone	1st Dorsal Spine	NA	9.27	No		2.15	No		
89	Pelagic Zone	Quadrate	R	12.87	No		8.20	No		
90	Inshore Zone	Lower Pharyngeal	NA		No			No		BURNED-DIDN'T MEASURE
91	Inshore Zone	Lower Pharyngeal	NA	4.08	No		3.40	No		
92	Inshore Zone	Premaxilla	UK	4.11	No		2.80	No		
144	Inshore Zone	Maxilla	L	5.61	Yes		2.73	Yes		
244	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
270		Quadrate	UK		No			No		
378	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure
379	Inshore Zone	1st Dorsal Spine	NA		No			No		very small fragment-didn't measure

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
151	Inshore Zone	Upper Pharyngeal	L	11.01	No		7.89	Yes		
188	Inshore Zone	1st Dorsal Spine	NA		No			No		UNMEASURABLE
189	Pelagic Zone	Dentary	L	11.54	No		2.43	Yes		
224	Inshore Zone	Lower Pharyngeal	NA	18.81	Yes		15.30	Yes		
304	Pelagic Zone	Maxilla	R	9.69	No		2.92	Yes		
93	Inshore Zone	Angular	R	6.28	Yes		4.56	Yes		
307	Inshore Zone	Maxilla	UK	10.07	No		5.83	No		
45	Inshore Zone	SCALE	NA	4.18	No		2.13	No		
94	Inshore Zone	Maxilla	L	10.77	Yes		8.42	Yes		
95	Inshore Zone	1st Dorsal Spine	NA	22.20	Yes		4.22	Yes		
96	Inshore Zone	Pelvis	NA		No			No		DIDN'T MEASURE
174	Inshore Zone	Upper Pharyngeal	R	4.42	No		3.47	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
255	Inshore Zone	Angular	R	13.85	Yes		6.67	Yes		
259	Inshore Zone	Angular	R	7.28	No		6.10	No		
289	Inshore Zone	Premaxilla	L	2.85	No		10.95	No		
303	Pelagic Zone	Maxilla	L	13.47	No		3.75	Yes		
306	Inshore Zone	Maxilla	UK	5.81	No		7.35	Yes		
143	Inshore Zone	1st Dorsal Spine	NA	20.02	No		8.27	Yes		
114	Inshore Zone	Scale	UK		No			No		
241	Inshore Zone	Premaxilla or Dentary	UK	2.08	No		2.56	No		
242	Inshore Zone	Spines	UK	1.59	Yes		4.91	Yes		
243	Inshore Zone	Spines	UK	1.58	Yes		5.24	Yes		
62	Inshore Zone	Upper Pharyngeal	L	10.64	No		1.81	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
63	Inshore Zone	Upper Pharyngeal	R	7.94	No		3.15	Yes		
133	Inshore Zone	Spines	UK	11.76	No		13.71	No		
134	Inshore Zone	1st Dorsal Spine	NA	14.57	No		3.09	Yes		
135	Inshore Zone	1st Dorsal Spine	NA	25.16	Yes		4.35	Yes		
136	Inshore Zone	Angular	R	10.66	Yes		9.73	Yes		
288	Pelagic Zone	Dentary	R	9.25	No		1.95	Yes		
113	Inshore Zone	Scale	UK		No			No		
97	Inshore Zone	Tooth	UK		No			No		DIDN'T MEASURE
137	Inshore Zone	1st Dorsal Spine	NA	24.22	Yes		4.26	Yes		
138	Inshore Zone	Lower Pharyngeal	NA	3.38	No		2.03	No		
139	Inshore Zone	Premaxilla	R	4.48	No		6.78	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
132		Angular	R	24.52	Yes		11.36	Yes		
162	Inshore Zone	Dentary	L	3.56	No		7.16	No		
6	Inshore Zone	UPH	L	6.67	No		2.60	Yes		
199	Inshore Zone	Lower Pharyngeal	NA	6.54	Yes		3.39	No		
202	Inshore Zone	Lower Pharyngeal	NA	7.14	Yes		4.18	Yes		
1	Inshore Zone	Lower Pharyngeal	NA	10.18	No	15.00	10.62	Yes		
140	Inshore Zone	1st Dorsal Spine	NA	16.84	No		3.38	No		
141	Inshore Zone	Maxilla	L	5.10	Yes		2.46	Yes		
142	Inshore Zone	Angular	L	4.75	Yes		2.27	No		
245	Inshore Zone	1ST Dorsal Spine OR PELVIS	NA		No			No		V. SMALL FRAG-DIDN'T MEASURE
41	Inshore Zone	LPH	NA	2.84	No		5.60	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
323	Inshore Zone	1st Dorsal Spine	NA	10.89	No		4.29	Yes		
324	Inshore Zone	1st Dorsal Spine	NA	15.91	No		3.93	Yes		
338	Other	Premaxilla	R	15.73	No		6.94	No		
343		Quadrate	L	8.81	No		5.85	No		
368	Inshore Zone	Lower Pharyngeal	NA		No			No		very small fragment-didn't measure
386		1st Dorsal Spine	NA	14.40	No		3.40	Yes		
387		1st Dorsal Spine	NA	14.67	No		3.50	Yes		
388		Spines	UK	6.42	No		5.18	No		
389		Quadrate	R	5.51	Yes		4.06	Yes		
390		Quadrate	UK		No			No		
391		Maxilla	L	4.36	Yes		1.35	Yes		
392		Tooth	UK		No			No		
393		Tooth			No			No		
345	Inshore Zone	1st Dorsal Spine	NA	9.74	No		3.97	Yes		
346	Inshore Zone	Dentary	R	10.07	No		8.07	Yes		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
382		Lower Pharyngeal	NA	7.84	Yes		4.58	Yes		
383		Angular	R	7.08	Yes		5.52	Yes		
395		Angular	UK	4.98	No		2.62	No		
396		Tooth	UK		No			No		
397		Dentary	R	4.20	Yes		3.94	Yes		
398		Lower Pharyngeal	NA		No			No		V.SMALL FRAG-DIDN'T MEASURE
394		Pelvis	NA	26.22	No		3.58	Yes		
16	Inshore Zone	UPH	L	5.66	No		2.42	Yes		
339	Pelagic Zone	Quadrate	UK	4.27	No		4.96	No		
344		Quadrate	R	28.18	No		23.08	No		
342		Quadrate	L		No			No		
351	Inshore Zone	Tooth	UK		No			No		
198	Inshore Zone	Lower Pharyngeal	NA	7.52	No	12.00	3.42	No		
334	Inshore Zone	Tooth	UK		No			No		HALF OF TOOTH PLATE

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
349	Inshore Zone	1st Dorsal Spine	NA	25.92	No		3.26	No		NOT SAME INDIVIDUAL AS ENTRY #350
350	Inshore Zone	1st Dorsal Spine	NA	8.77	No		3.84	Yes		NOT SAME INDIVIDUAL AS ENTRY #349
14	Inshore Zone	UPH	L	5.73	No		2.97	Yes		
46	Inshore Zone	PM	R	15.78	No		3.44	No		
200	Inshore Zone	Premaxilla	L	15.61	Yes		24.41	Yes		
213	Inshore Zone	Lower Pharyngeal	NA	15.82	Yes		14.51	No		
214	Inshore Zone	Lower Pharyngeal	NA	17.04	No	27.00	16.80	No		
335	Inshore Zone	Tooth			No			No		HALF OF TOOTH-FITS WITH ENTRY #334
341	Inshore Zone	Premaxilla	L	10.16	No		7.80	No		
347	Inshore Zone	Dentary	R	33.98	No		32.73	Yes		
348	Inshore Zone	Dentary	L	27.28	No		22.57	No		

ID	Patch	Element	Side	Length	LComplete	LETL	Width/Height	WComplete	WETL	Comment
333	Inshore Zone	Tooth	UK		No			No		WHOLE TOOTH (BOTH SIDES)
48	Inshore Zone	LPH	NA	5.55	No		4.24	No		
8	Inshore Zone	UPH	R	6.70	No		5.98	Yes		
327	Inshore Zone	Premaxilla or Dentary	UK	6.25	No		3.05	No		

Appendix 5

Table of evenness, NTAXA, and densities for each excavation unit

Unit	Period	Fish Species Richness (S) [NTAXA]	Fish Evenness	IDF MNI	IDF NISP	Fish NISP	Fish NISP Density (NISP/level count total)	Fish Weight (g)	Fish Weight Density (g/level weight total)	Mollusk Count (NISP)	Mollusk Count Density (NISP/le count tot
KAL10ATU1	4	3	0.9141009	7	7	842	0.418697166	4.94	0.0084	1095	0.54450
KAL10ATU2	4	2	1	2	2	718	0.286283892	3.61	0.005938281	1781	0.71012
KAL10BTU3	4	2	1	2	4	1101	0.235206153	10.86	0.020780712	3563	0.76116
KAL10CTU4	4	2	0.9182959	3	3	513	0.456	2.85	0.016013935	594	0.
KAL10CTU5	4	3	1	3	3	1377	0.463948787	10.38	0.056677951	1451	0.4888
KAL10CTU6	4	4	0.960964	5	9	1497	0.506085193	13.09	0.005955468	1413	0.47768
KAL1TU1	1	0	NaN	0	0	354	0.910025707	3.73	0.54057971	35	0.08997
KAL23ATU1	4	0	NaN	0	0	71	0.177944862	0.54	0.000723977	326	0.81704
KAL23ATU3	4	2	0.8112781	4	7	627	0.255813953	4.34	0.011452094	1813	0.73969
KAL23BTU2	4	1	NaN	1	2	1207	0.323505763	8.37	0.018248414	2481	0.66496
KAL30ATU1A	2	0	NaN	0	0	0	0	0	0	356	0.98888
KAL30ATU1B	2	0	NaN	0	0	46	0.027828191	1.56	0.004936396	1605	0.97096
KAL30ATU1BAULK	2	3	1	3	3	693	0.238636364	3.52	0.004542697	2206	0.75964
KAL30BTU2	3	9	0.9483628	13	17	62	0.849315068	20.86	0.876839008	1	0.01369
KAL30BTU2BAULK	3	2	1	2	3	1255	0.325466805	10.38	0.025318308	2601	0.6745
KAL5ATU1	3	6	0.9329351	13	30	266	0.07206719	19.37	0.030963761	3423	0.92739
KHL10TU1	2	0	NaN	0	0	10	0.076923077	0.17	0.015813953	106	0.81538
KHL12TU1	2	0	NaN	0	0	1	0.142857143	3.73	0.88179669	0	
KHL1TU1	3	0	NaN	0	0	0	0	0	0	4	

Unit	Period	Fish Species Richness (S) [NTAXA]	Fish Evenness	IDF MNI	IDF NISP	Fish NISP	Fish NISP Density (NISP/level count total)	Fish Weight (g)	Fish Weight Density (g/level weight total)	Mollusk Count (NISP)	Mollusk Count Density (NISP/le count tot
KHL2ATU1	2	2	1	2	2	5	0.0029994	0.18	0.00168808	21	0.01259
KHL2BTU4	ND	2	0.9182959	3	3	21	0.049065421	1.32	0.014808167	331	0.77336
KHL2HTU3	3	5	0.960964	5	5	126	0.077538462	5.73	0.01903781	1388	0.85415
KHL48TU1	3	0	NaN	0	0	0	0	0	0	3	0.42857
KHL50TU1	ND	0	NaN	0	0	0	0	0	0	158	0.66949
KHL50TU2	ND	0	NaN	0	0	10	1	0.14	1	0	
MKE103TU1	2	0	NaN	0	0	1	0.02	0.03	0.005136986	49	0
MKE103TU2	ND	0	NaN	0	0	1	0.005102041	0.04	0.00063857	195	0.99489
MKE104TU1	2	1	NaN	1	2	265	0.443886097	11.28	0.279623203	329	0.55108
MKE105TU1	2	1	NaN	1	1	96	0.089552239	3.19	0.012284823	970	0.90485
MKE106TU1	1	3	1	3	3	85	0.017782427	6.05	0.00669344	4695	0.98221
MKE107TU1	ND	2	0.9182959	3	3	8	0.005657709	4.16	0.009596752	1406	0.99434
MKE108ATU1	3	4	0.8085948	11	36	132	0.060829493	13.58	0.023310103	2038	0.93917
MKE108BTU2	ND	6	0.8982444	10	11	2317	0.655074922	15.08	0.030428378	1210	0.34209
MKE1TU3	ND	0	NaN	0	0	0	0	0	0	0	
MKE2ATU1	3	0	NaN	0	0	15	0.015873016	0.48	0.004023808	828	0.87619
MKI11ATU1	3	2	0.9709506	5	5	102	0.077862595	1.71	0.005306933	1144	0.87328
MKI13TU1	ND	0	NaN	0	0	171	0.621818182	0.78	0.049087476	96	0.34909
MKI198BTU1	3	0	NaN	0	0	1	0.018518519	0.06	0.000142295	42	0.77777
MKI199ATU1	2	0	NaN	0	0	18	0.033395176	1.2	0.032137118	426	0.7903
MKI1ATU1	3	7	0.9479479	13	14	3356	0.265590377	31.7	0.011103989	9212	0.72902
MKI1ATU3	ND	0	NaN	0	0	3	0.004491018	0.02	6.87026E-05	662	0.99101
MKI23ATU1	3	3	1	6	6	1470	0.512909979	10.77	0.036154285	1388	0.48429
MKI23ATU2	ND	1	NaN	2	2	60	0.020359688	0.45	0.000388661	2885	0.97896

Unit	Period	Fish Species Richness (S) [NTAXA]	Fish Evenness	IDF MNI	IDF NISP	Fish NISP	Fish NISP Density (NISP/level count total)	Fish Weight (g)	Fish Weight Density (g/level weight total)	Mollusk Count (NISP)	Mollusk Count Density (NISP/le count tot
MKI24TU1	ND	1	NaN	1	1	53	0.130864198	0.47	0.004067503	351	0.86666
MKI24TU2	ND	0	NaN	0	0	44	0.122562674	0.4	0.004403347	315	0.87743
MKI25BTU3	3	3	0.9463946	4	4	255	0.303933254	4.27	0.004989017	542	0.64600
MKI25TU1	ND	2	1	2	2	35	0.071721311	0.59	0.006772268	451	0.92418
MKI25TU2	ND	1	NaN	1	1	248	0.397435897	0.76	0.007907606	376	0.6025
MKI2ATU1	2	3	0.9206199	7	7	762	0.092040101	10.1	0.003073141	7493	0.905
MKI2ATU2	2	4	0.8903195	13	30	1599	0.170942912	29.5	0.008313091	7706	0.82381
MKI2CTU3	3	6	0.967132	7	8	450	0.098597721	9.02	0.012525342	4102	0.89877
MKI300TU1	ND	1	NaN	2	2	0	0	0	0	9	0.09278
MKI301ATU1	3	3	0.7896901	6	7	62	0.354285714	1.37	0.044771242	55	0.31428
MKI301TU2	2	0	NaN	0	0	2	0.064516129	0.45	0.061728395	16	0.51612
MKI303TU1	1	2	1	4	4	101	0.431623932	3.2	0.093267269	38	0.16239
MKI304ATU1	3	4	1	4	4	108	0.151685393	3.41	0.060751826	432	0.60674
MKI306TU1	3	3	0.8649736	5	5	130	0.092658589	17.1	0.074980268	1227	0.87455
MKI307TU1	3	0	NaN	0	0	24	0.090225564	0.87	0.052504526	168	0.63157
MKI378ATU1	2	2	0.9182959	3	5	71	0.075531915	1.75	0.011942947	531	0.56489
MKI378BTU2	ND	2	0.9182959	3	6	40	0.291970803	2.82	0.178707224	95	0.69343
MKI378CTU3	ND	2	1	2	2	38	0.28358209	1.97	0.221846847	27	0.20149
MKI414TU1	3	4	0.9211855	7	8	77	0.316872428	2.36	0.141148325	129	0.5308
MKI56TU1	3	10	0.89043	27	39	4588	0.332970462	57.03	0.021517507	9019	0.65454
PHH13ATU1	1	11	0.9250909	27	39	8434	0.711790024	140.81	0.097984774	3394	0.28643
PHH30TU1	1	2	0.9182959	3	3	128	1	6.5	1	0	

Unit	Mollusk Weight (g)	Mollusk Weight Density (g/level weight total)	Mammal Count (NISP)	Mammal Count Density (NISP/level count total)	Mammal Weight (g)	Mammal Weight Density (g/level weight total)	Bird Count (NISP)	Bird Count Density (NISP/level count total)	Bird Weight (g)	Bird Weight Density (g/level weight total)
KAL10ATU1	578.92	0.9899	60	0.02984	0.92	0.00157	14	0.00696	0.04	2E-05
KAL10ATU2	603.8	0.99322	8	0.00319	0.42	0.00069	1	0.0004	0.09	3.6E-05
KAL10BTU3	509.1	0.97417	17	0.00363	2.64	0.00505	0	0	0	0
KAL10CTU4	174	0.97769	18	0.016	1.12	0.00629	0	0	0	0
KAL10CTU5	167.61	0.9152	140	0.04717	5.15	0.02812	0	0	0	0
KAL10CTU6	631.6	0.28735	48	0.01623	1553.29	0.70669	0	0	0	0
KAL1TU1	3.17	0.45942	0	0	0	0	0	0	0	0
KAL23ATU1	672.8	0.90202	2	0.00501	72.54	0.09725	0	0	0	0
KAL23ATU3	374.2	0.98741	11	0.00449	0.43	0.00113	0	0	0	0
KAL23BTU2	450.1	0.98132	43	0.01153	0.2	0.00044	0	0	0	0
KAL30ATU1A	101.11	0.98644	4	0.01111	1.39	0.01356	0	0	0	0
KAL30ATU1B	313.95	0.99345	2	0.00121	0.51	0.00161	0	0	0	0
KAL30ATU1BAULK	771.2	0.99526	5	0.00172	0.15	0.00019	0	0	0	0
KAL30BTU2	1	0.04203	10	0.13699	1.93	0.08113	0	0	0	0
KAL30BTU2BAULK	399.6	0.97468	0	0	0	0	0	0	0	0
KAL5ATU1	606.03	0.96876	2	0.00054	0.17	0.00027	0	0	0	0
KHL10TU1	8.13	0.75628	14	0.10769	2.45	0.22791	0	0	0	0
KHL12TU1	0	0	6	0.85714	0.5	0.1182	0	0	0	0
KHL1TU1	1.2	1	0	0	0	0	0	0	0	0
KHL2ATU1	7.43	0.06968	1641	0.9844	99.02	0.92863	0	0	0	0
KHL2BTU4	77.32	0.8674	76	0.17757	10.5	0.11779	0	0	0	0

Unit	Mollusk Weight (g)	Mollusk Weight Density (g/level weight total)	Mammal Count (NISP)	Mammal Count Density (NISP/level count total)	Mammal Weight (g)	Mammal Weight Density (g/level weight total)	Bird Count (NISP)	Bird Count Density (NISP/level count total)	Bird Weight (g)	Bird Weight Density (g/level weight total)
KHL2HTU3	279.44	0.92843	109	0.06708	15.59	0.0518	2	0.00123	0.22	0.00014
KHL48TU1	12.78	0.97186	4	0.57143	0.37	0.02814	0	0	0	0
KHL50TU1	12.12	0.7528	78	0.33051	3.98	0.2472	0	0	0	0
KHL50TU2	0	0	0	0	0	0	0	0	0	0
MKE103TU1	5.81	0.99486	0	0	0	0	0	0	0	0
MKE103TU2	62.6	0.99936	0	0	0	0	0	0	0	0
MKE104TU1	26.7	0.66187	3	0.00503	2.36	0.0585	0	0	0	0
MKE105TU1	254.6	0.98048	6	0.0056	1.88	0.00724	0	0	0	0
MKE106TU1	897.46	0.99291	0	0	0.36	0.0004	0	0	0	0
MKE107TU1	429.32	0.9904	0	0	0	0	0	0	0	0
MKE108ATU1	569	0.97669	0	0	0	0	0	0	0	0
MKE108BTU2	475.67	0.95981	10	0.00283	4.84	0.00977	0	0	0	0
MKE1TU3	0	0	4	1	0	0	0	0	0	0
MKE2ATU1	88.42	0.74122	102	0.10794	30.39	0.25476	0	0	0	0
MKI11ATU1	317.16	0.9843	64	0.04885	3.35	0.0104	0	0	0	0
MKI13TU1	14.18	0.89239	8	0.02909	0.93	0.05853	0	0	0	0
MKI198BTU1	421.46	0.99953	11	0.2037	0.14	0.00033	0	0	0	0
MKI199ATU1	33.22	0.88966	95	0.17625	2.92	0.0782	0	0	0	0
MKI1ATU1	2816.07	0.98642	65	0.00514	7.06	0.00247	3	0.00024	0	0
MKI1ATU3	291.02	0.99969	3	0.00449	0.07	0.00024	0	0	0	0
MKI23ATU1	286.8	0.96277	7	0.00244	0.31	0.00104	1	0.00035	0.01	3.5E-06
MKI23ATU2	1157.22	0.99948	2	0.00068	0.15	0.00013	0	0	0	0
MKI24TU1	115.05	0.99567	1	0.00247	0.03	0.00026	0	0	0	0

Unit	Mollusk Weight (g)	Mollusk Weight Density (g/level weight total)	Mammal Count (NISP)	Mammal Count Density (NISP/level count total)	Mammal Weight (g)	Mammal Weight Density (g/level weight total)	Bird Count (NISP)	Bird Count Density (NISP/level count total)	Bird Weight (g)	Bird Weight Density (g/level weight total)
MKI24TU2	90.44	0.9956	0	0	0	0	0	0	0	0
MKI25BTU3	847.44	0.99014	42	0.05006	4.17	0.00487	0	0	0	0
MKI25TU1	86.43	0.99208	2	0.0041	0.1	0.00115	0	0	0	0
MKI25TU2	95.35	0.99209	0	0	0	0	0	0	0	0
MKI2ATU1	3272.54	0.99574	24	0.0029	3.9	0.00119	0	0	0	0
MKI2ATU2	3506.34	0.98809	49	0.00524	12.78	0.0036	0	0	0	0
MKI2CTU3	708.39	0.98368	12	0.00263	2.73	0.00379	0	0	0	0
MKI300TU1	9.38	0.58515	88	0.90722	6.65	0.41485	0	0	0	0
MKI301ATU1	15.88	0.51895	58	0.33143	13.35	0.43627	0	0	0	0
MKI301TU2	4.94	0.67764	13	0.41935	1.9	0.26063	0	0	0	0
MKI303TU1	0.45	0.01312	95	0.40598	30.66	0.89362	0	0	0	0
MKI304ATU1	43.51	0.77516	172	0.24157	9.21	0.16408	0	0	0	0
MKI306TU1	208.51	0.91428	46	0.03279	2.45	0.01074	0	0	0	0
MKI307TU1	10.65	0.64273	74	0.2782	5.05	0.30477	0	0	0	0
MKI378ATU1	68.45	0.46714	338	0.35957	76.33	0.52092	0	0	0	0
MKI378BTU2	12.88	0.81622	2	0.0146	0.08	0.00507	0	0	0	0
MKI378CTU3	1.52	0.17117	69	0.51493	5.39	0.60698	0	0	0	0
MKI414TU1	13.4	0.80144	37	0.15226	0.96	0.05742	0	0	0	0
MKI56TU1	2582.87	0.97452	170	0.01234	10.41	0.00393	2	0.00015	0.09	6.5E-06
PHH13ATU1	1281.2	0.89154	21	0.00177	15.05	0.01047	0	0	0	0
PHH30TU1	0	0	0	0	0	0	0	0	0	0

Unit	Level Count Total	Level Weight Total	Count Evenness Value	Weight Evenness Value
KAL10ATU1	2011	584.82	0.60224	0.04413
KAL10ATU2	2508	607.92	0.44912	0.0314
KAL10BTU3	4681	522.6	0.51751	0.1208
KAL10CTU4	1125	177.97	0.69311	0.10937
KAL10CTU5	2968	183.14	0.7739	0.31331
KAL10CTU6	2958	2197.98	0.69584	0.57727
KAL1TU1	389	6.9	0.43638	0.99524
KAL23ATU1	399	745.88	0.45405	0.29573
KAL23ATU3	2451	378.97	0.54254	0.06498
KAL23BTU2	3731	458.67	0.6261	0.08642
KAL30ATU1A	360	102.5	0.08807	0.10357
KAL30ATU1B	1653	316.02	0.12417	0.03925
KAL30ATU1BAULK	2904	774.87	0.51129	0.02811
KAL30BTU2	73	23.79	0.42763	0.41164
KAL30BTU2BAULK	3856	409.98	0.91023	0.17034
KAL5ATU1	3691	625.57	0.23988	0.12795
KHL10TU1	130	10.75	0.54952	0.5652
KHL12TU1	7	4.23	0.59167	0.52417
KHL1TU1	4	1.2	1	1
KHL2ATU1	1667	106.63	0.0801	0.24135
KHL2BTU4	428	89.14	0.59492	0.39842
KHL2HTU3	1625	300.98	0.37683	0.21855
KHL48TU1	7	13.15	0.98523	0.18496
KHL50TU1	236	16.1	0.91545	0.80682
KHL50TU2	10	0.14	1	1

Unit	Level Count Total	Level Weight Total	Count Evenness Value	Weight Evenness Value
MKE103TU1	50	5.84	0.14144	0.04646
MKE103TU2	196	62.64	0.04619	0.0077
MKE104TU1	597	40.34	0.65127	0.72413
MKE105TU1	1072	259.67	0.30546	0.09927
MKE106TU1	4780	903.87	0.1288	0.03977
MKE107TU1	1414	433.48	0.05038	0.07811
MKE108ATU1	2170	582.58	0.33073	0.15964
MKE108BTU2	3537	495.59	0.60135	0.17372
MKE1TU3	4	0	1	1
MKE2ATU1	945	119.29	0.38399	0.53934
MKI11ATU1	1310	322.22	0.42288	0.0827
MKI13TU1	275	15.89	0.69699	0.37837
MKI198BTU1	54	421.66	0.54018	0.004
MKI199ATU1	539	37.34	0.55108	0.37664
MKI1ATU1	12636	2854.83	0.44119	0.07127
MKI1ATU3	668	291.11	0.05233	0.0027
MKI23ATU1	2866	297.89	0.51292	0.11834
MKI23ATU2	2947	1157.82	0.09562	0.00431
MKI24TU1	405	115.55	0.36862	0.02626
MKI24TU2	359	90.84	0.53668	0.0408
MKI25BTU3	839	855.88	0.72286	0.05661
MKI25TU1	488	87.12	0.25886	0.04504
MKI25TU2	624	96.11	0.96943	0.06658
MKI2ATU1	8279	3286.54	0.29745	0.02733
MKI2ATU2	9354	3548.62	0.44522	0.06547
MKI2CTU3	4564	720.14	0.30945	0.0839

Unit	Level Count Total	Level Weight Total	Count Evenness Value	Weight Evenness Value
MKI300TU1	97	16.03	0.44569	0.97898
MKI301ATU1	175	30.6	0.9989	0.76583
MKI301TU2	31	7.29	0.80341	0.71551
MKI303TU1	234	34.31	0.93191	0.34463
MKI304ATU1	712	56.13	0.84871	0.60453
MKI306TU1	1403	228.06	0.40934	0.29572
MKI307TU1	266	16.57	0.78571	0.72906
MKI378ATU1	940	146.53	0.80603	0.681
MKI378BTU2	137	15.78	0.61443	0.45537
MKI378CTU3	134	8.88	0.93022	0.85492
MKI414TU1	243	16.72	0.89833	0.56237
MKI56TU1	13779	2650.4	0.50428	0.09368
PHH13ATU1	11849	1437.06	0.55646	0.34381
PHH30TU1	128	6.5	1	1